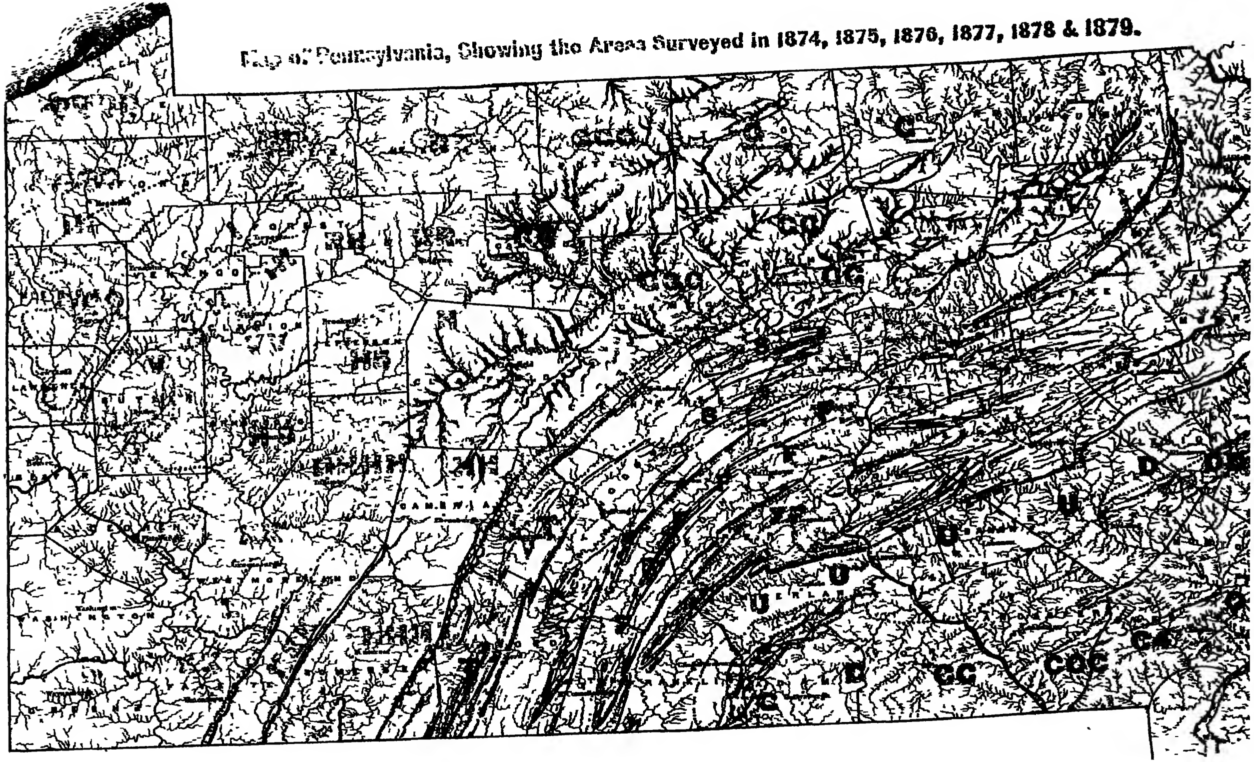

Map of Pennsylvania, Showing the Areas Surveyed in 1874, 1875, 1876, 1877, 1878 & 1879.

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA:
REPORT OF PROGRESS.
R

THE GEOLOGY OF

McKEAN COUNTY,

AND
ITS CONNECTION WITH
THAT OF

CAMERON, ELK AND FOREST.

BY
CHAS. A. ASHBURNER.

ILLUSTRATED BY 33 PAGE PLATES AND 2 MAPS, AND
ACCOMPANIED BY AN ATLAS
CONTAINING 8 SHEETS OF MAPS AND SECTIONS.

HARRISBURG:
PUBLISHED BY THE BOARD OF COMMISSIONERS
FOR THE SECOND GEOLOGICAL SURVEY.
1880.

1880.

ASSISTANT GEOLOGISTS.

PERSIFOR FRAZER—Geologist in charge of the Survey of Chester county.

AMBROSE E. LEHMAN—Topographical Assistant, for mapping the South Mountain.

E. V. D'INVILLIERS—Topographical Assistant, for mapping the Easton-Reading range.

FRANKLIN PLATT—Geologist in charge of the Satistical Survey of the Anthracite coal fields, &c.

W. G. PLATT—Geologist in charge of the Survey of Armstrong and Jefferson counties.

R. H. SANDERS—Topographical Assistant in Franklin county.

I. C. WHITE—Geologist in charge of the Survey of Susquehanna and Wayne counties.

J. F. CARLL—Geologist in charge of the Survey of the Oil Regions.

H. M. CHANCE—Geologist to report on the Mining of the Anthracite coal fields.

C. A. ASHBURNER—Geologist to report on the Geology of the Anthracite coal fields.

A. W. SHEAFER—Assistant in the Anthracite coal fields.

F. A. GENTH—Mineralogist and Chemist at Philadelphia.

F. A. GENTH, Jr—Aid in the Laboratory.

A. S. McCREATH— Chemist, in charge of the Laboratory of the Survey, 223 Market street, Harrisburg.

JOHN M. STINSON—Aid in the Laboratory at Harrisburg.

C. E. HALL— Geologist in charge of the Survey of the Philadelphia belt, and Palæontologist in charge of the Museum.

M. CHAPMAN—Aid in the Museum.

H. C. LEWIS—Volunteer geologist for the survey of the gravel deposits of south-eastern Pennsylvania.

LEO LESQUEREUX—Fossil Botanist, Columbus, Ohio.

E. B. HARDEN—Topographer in charge of Office Work, &c. 1008 Clinton street, Philadelphia.

F. W. FORMAN—Clerk in charge of the Publications of the Survey, 223 Market street, Harrisburg.

CHARLES ALLEN—Aid.

PHILADELPHIA, *August 10, 1880.*

To His Excellency Governor HENRY M. HOYT,

Chairman of the Board of Commissioners of the Second Geological Survey of Pennsylvania:

SIR: I have the honor to submit the following report on the progress of the Survey in the district of McKean, Cameron, Elk and Forest counties, by Assistant geologist Mr. Charles A. Ashburner; together with numerous maps, sheets of sections, and page illustrations, executed with great skill and carefulness.

This report, devoted chiefly to the geology of McKean county, will speak for itself; but I invite your special attention to some of its features, as follows:

1. The Survey is largely instrumental; original horizontal and vertical measurements having been made the basis of all determinations of strata. But with this has been interwoven a large amount of instrumental surveying done by railway and mining engineers; as well as a large amount of vertical measurement from oil well records. All determined points on the surface, and in the wells, are referred to tide-level; and a sufficient number of these points are figured on the maps. Contour curves upon the maps show the relationship of these points to each other, and to the outcrops of the coal beds. Colors are employed to distinguish the outcrops of the formations, and the areas of the workable coal beds.

2. The sheets of vertical sections are so arranged as to show the thickening and thinning of some of the formations in certain directions, for the purpose of guiding oil well sinkers in their calculations of the probable depth of the oil bearing rocks at any given locality. And to facilitate the use of the sections a red color has been given to

the "red rocks" which intervene between the surface and the oil.

A special map shows the present limits of the Bradford oil field, which is now the most important in the world, and in which a good deal of future work should be done by the Survey for the sake of its peculiar geology.

3. The breaking up of the old indefinite "Formation No. XII," into a group of well-defined sand rocks and coal intervals, and the determination of its true relationships with the Coal Measures proper overlying it, and with the Formations No. XI, X, and IX underneath it, has been the distinguishing success of this survey; which thus affords a reliable key to the long desired harmony between the eastern and western coal fields; besides throwing a flood of light on the geology of the lower Coal Measures and sub-carboniferous formations across the whole State.

The application of the conclusions reached in McKean county to the neighboring counties on the south is indicated in the first part of the report, and will be fully displayed in Mr. Ashburner's report on those counties now preparing.

Very respectfully,

Your obedient servant,

J. P. LESLEY.

PHILADELPHIA, *August 2, 1880.*

Professor J. P. LESLEY, *State Geologist:*

DEAR SIR: I have the honor to submit to you my report of the progress of the survey in McKean, Cameron, Elk, and Forest counties.

Part first is a summary statement of the stratification of the whole district, with the special object in view of explaining the geology of McKean county.

Part second is a detailed description of the geology of the several townships of McKean county.

The detailed geology of the townships of Cameron, Elk, and Forest counties will be described in a separate report.

Field work was commenced in July, 1876. My detailed survey of McKean was not finished until the autumn of 1878. Meanwhile, however, much work had been done in the adjoining counties of Cameron and Elk. This work had a necessary bearing upon the satisfactory explanation of difficulties encountered in McKean.

Most of the illustrations were drawn, placed on stone, and printed before the autumn of 1879. The manuscript was prepared in the winter and spring of 1880.

The classified sub-divisions of the formations, used in this report, I adopted after a study of the whole region lying between Oil City in Venango county and Renovo in Clinton county, an east and west stretch of about one hundred miles, and between the Jefferson county line and the New York State line, a stretch of sixty miles north and south.

The names by which I designate the Coal-measure rocks in my district, and the age to which I am led to assign the Venango oil group, are two subjects of consideration fully discussed in my report.

During the past thirty years numerous local surveys in McKean county have been made by geological experts, in

the employ of private individuals or companies, for developing the mineral resources of the region, and their reports have been printed and widely circulated.

It was not my business in this report to criticise or review professional opinions thus published, whether relating to geological facts or property values. I can only say, that the region is one of great difficulty; that the natural exposures are scarce and widely separated; that only the lowest of the coal-measures exist, and these are variable; and that it would be impossible for the most thoroughbred geologist to succeed in a short examination of one locality. In fact, it was only after a slow, patient, and very protracted survey of the whole area, after the collation of all kinds of fact from every locality in it, and after the comparison of a multitude of sections in all four counties, that I reached conclusions on which I could rely with confidence.

In 1841, the last year of the First Geological Survey of Pennsylvania, when the region was an unbroken wilderness, it was rapidly examined on horseback by Professor Lesley, whose notes were used in the final report of 1858, with others taken in subsequent years by Professor H. D. Rogers. At that time No. XII (the Pottsville conglomerate) was supposed to be solid, and to underlie all the coal beds.

In May, 1853, Professor James Hall, Geologist of the Fourth District of the New York State Survey,* examined the 6,000 acres of the Lafayette Mineral Company in Lafayette township.

In 1854, Dr. Salisbury, of the New York Geological Survey, examined the 5,000 acres of the Backus lands in Liberty and Keating townships.

In 1854, Mr. Allen Putnam, of Boston, published his report of examinations of coal lands north of the Kinzua creek, and south of the Bingham estate lands.

In 1855, Mr. Peter W. Sheafer, of the Geological Survey of Pennsylvania, reported on the Monroe Coal and Iron Company's estate, in Norwich and Keating townships.

In 1856, Mr. Sheafer reported on the Silver Hill Coal and Iron Estate, in McKean county. During the summer of

* Quarto report published in 1843.

the same year, Mr. Sheafer commenced a geological examination of the lands of the Bingham estate. This work was continued until 1858, when a report was made to Mr. William B. Clymer, agent. I believe this report was never published.

In 1856 and 1857, Mr. Augustus F. Dalson, of the Geological Survey of Pennsylvania, made extensive surveys of parts of the McKean, Elk Land and Improvement Company, about Howard hill, in Hamlin township. Two annual reports to the company were published.

In the autumn of 1856 and following winter, Dr. David Dale Owen, geologist of various United States and State surveys in the west, and Mr. B. Needham, examined the lands of D. Kingsbury and others, in the northwestern part of the county. Their report of 56 printed pages appeared in 1857.

In September, 1857, a report was published, entitled "The McKean Coal and Iron Region, and the works required for an outlet to market ; by a committee of the officers of the McKean County railroad."

In 1864, Mr. Putnam published a report on lands near Buttsville.*

In June, 1868, Mr. Joseph Lesley's report of his surveys was published in a pamphlet, entitled "Maps and Descriptions . . . of coal, timber, farm, and hemlock lands . . . of the McKean, Elk Land and Improvement Company." Other publications of the same company contain important geological data.

In 1875, Mr. Ira Winans published a pamphlet, entitled "Statistics and comments regarding Rochester's commercial relations and their connection with the great commodities coal and iron," with special references to the Potato creek coal basin east of Norwich.

In 1877, Mr. Winans published another pamphlet on the "Coal, Iron, and Oil of McKean county, Pennsylvania."

Many other private reports have been made which have

*I am informed that Professor William F. Roberts had already published a report on these lands, but I have not been able to find a copy.

never been published, some of which I have been permitted to read in manuscript.

I wish to express in the highest terms my appreciation of the diligence, faithfulness, and ability with which my aid, Mr. A. W. Sheafer, has assisted me for the past two years.

During 1876 and 1877, my friend Mr. Rodman McIlvaine and Mr. W. A. Fellows rendered me at times valuable help.

In all parts of the district there was an expressed willingness on the part of the residents and those having interests to further my work in every possible way; their names are too numerous to record; among those who gave special assistance, may be mentioned Mr. James E. Butts, Jr., of Buttsville; Hon. Lewis Emery, Jr., Mr. Henry M. Ernst, Mr. L. C. Blakeslee, Mr. John Brown, and Col. A. I. Wilcox, of Bradford; Mr. Henry Hamlin, and Mr. Seth A. Backus, of Smethport; Mr. Grahame Macfarlane, formerly of Clermont, now of Towanda; Capt. A. A. Clay, of Upland, Elk county; Mr. William Hacker, and Mr. Henry Clay, of Philadelphia; Maj. Gen. Thomas L. Kane, of Kane; Mr. William A. Baldwin, and Mr. A. B. Starr, of the P. & E. R. R.; Mr. J. S. Beggs, of the N. Y., L. E. and W. R. R.; Hon. C. R. Earley, of Ridgway; Mr. Oliver W. Barnes, C. E., of New York; Mr. S. V. Godden, of the McK. and B. R. R.; Mr. George S. Gatchell, of the B. N. Y. & P. R. R., and many others.

Before closing this letter, I wish to express my sincere appreciation of the valuable counsel and assistance which you have so constantly rendered me, and to thank you for your kindly interest and instruction to which any professional success I may have secured must be largely due.

I remain, with the greatest respect,

Your obedient servant,

CHAS. A. ASHBURNER.

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PART I.—General Geology of the District.

LIST OF ILLUSTRATIONS, R.

LIST OF ILLUSTRATIONS IN THE ATLAS.

NOTE.—The columnar sections are drawn on two scales, 10′ : 1″ and 20′ : 1″. *The latter are designated by italics in brackets*, thus:

Figs. 3 to 10, [*11, 12, 13, 14*,] 15, 16, [*17, 18*,] 19, 20, [*22, 23*,] 24 to 30, [*31*,] 32 to 34, [*35, 36*,] 37, [*38*,] 39, 40, [*41, 42*,] 43, 44, [*45, 46*,] 47 to 50, [*51*,] 52 to 54, [*55*,] 56 to 58, [*59*,] 60, [*61*,] 62, 63, [*64*,] 65, [*66*,] 67, 68, [*71*,] 72 to 87, [*88 to 93*,] 94 to 98, [*99 to 107*,] 108 to 119, [*120 to 126*,] 127 to 132, [*133 to 136*,] 137 to 140, [*141*.]

REPORT OF THE PROGRESS

OF THE

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA

IN

McKEAN COUNTY

By Chas. A. Ashburner.

PART I.

SUMMARY STATEMENT OF THE GEOLOGY OF THE DISTRICT.

Chapter I.

§ *1. Area, Boundary, &c.;* § *5. Topographical Features;* § *7. Drainage Basins;* § *16. Dividing Ridges;* § *20. Railroad communications;* § *23. Elevations above tide.*

Area, Boundary, &c.

§ 1. McKean county is one of the eight northern counties of Pennsylvania bounded on the north by the State of New York.

All the counties in this tier, with the exception of the eastern (Wayne county) and the western (Erie county), are nearly rectangular; their boundary lines have a general direction north and south, east and west. The remaining six counties, Susquehanna, Bradford, Tioga, Potter, McKean and Warren, are among the largest in the State and have the most regular outlines.

§ 2. The northern boundary line of the county is a portion of the New York, Pennsylvania State line; has an east and west course and is 37 miles± long.

The line separating McKean from Potter on the east has a north and south direction; its length is $26\frac{1}{4}$ miles±.

The southern line separating the county from Elk and Cameron is broken; the greater part of it has an east and west course. The width of the county here is $38\frac{1}{4}$ miles±.

The line between McKean and Warren is also broken by right angled jogs; its length projected into a north and south line is $25\frac{3}{4}$ miles±.

§ 3. McKean county was formed March 20th, 1804, and set off from Lycoming. Its county seat Smethport was not laid out till 1807. It contains 980 squares mile (more or less). Since the county was formed its area has been reduced several times; by the formation of new counties and by the readjustment of its boundaries. In 1843, Elk was formed from portions of Jefferson, Clearfield and McKean; and in 1860, when Cameron was formed, Shippen township was taken from McKean.

§ 4. It is subdivided into 14 townships arranged somewhat as follows:

					5. Ceres.
1. Corydon.	2. Bradford.		3. Otto.	4. Eldred.	
					6. Annin.
7. Hamilton.	8. Lafayette.			9. Keating.	
		11. Hamlin.			14. Liberty.
10. Wetmore.			12. Sergeant.	13. Norwich.	

Topographical Features.

§ 5. McKean county may be called the plateau county of northern Pennsylvania. Broad, flat, elevated plateaux; not comparatively deep, narrow and sharp valleys, are the distinguishing features. To a balloonist, viewing its surface several thousand feet above the highest summits, it would appear as a rolling prairie, which had been broken up by comparatively shallow meandering valleys. In this simple and natural conception lies embodied the characteristics of the topography, resulting from erosion in horizontal strata.

§ 6. All the rocks of the northwestern part of our State are sedimentary; at the time of their formation, the area of McKean, which is now at a mean height of nearly 2000′ above the surface of the ocean, may then have been some thousand feet under water level. When it was for the last time elevated above the ocean, or the water was drawn from its surface,* it was doubtless as flat and unbroken as any prairie now to be found in the Mississippi valley. The mountains have not been, as so often popularly conceived, *upheaved* but the valleys have been eroded out by the agents, air and water.

At first glance the direction and size of the valleys seem to have been determined by mere chance; upon closer inspection it will be found that the geological structure has defined the topographical details.

If the drainage basins be outlined on the county map, it will be noticed that the main direction of the valleys north-east and south-west of the *Kinzua-Emporium cross anticlinal axis* is mainly away from the axis; except, the main Kinzua creek valley which lies over and in the direction of the axis. When erosion first commenced, this axis was no doubt boldly marked by greater elevation of the surface. This ridge would naturally form a divide between the north-east and south-west drainage, determining the general direction of the water flow.

West of the *Smethport anticlinal* (*Fifth*) *axis*, the topography does not seem to have been governed by any special structure. In fact the dips of the outcropping strata are so small (10′ to 30′ per mile) and regular, that we cannot believe them to have had any determinate action upon the erosion. East of this axis the main direction of the streams is either parallel or perpendicular to the axis. Marvin creek and most of the streams in Annin, Liberty and Norwich townships illustrate this fact.

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*As the bulk of water on the earth's surface is not known to decrease, the ocean could only be withdrawn from the surface at any one place by elevations and depressions taking place in other localities which would necessarily tend to change the relative heights of water and land over the entire globe.

Drainage Basins.

§ 7. The area of the county may be divided into eight distinct water basins; seven of them send their water into the gulf of Mexico through the Allegheny, Ohio and Mississippi rivers; the eighth and smallest drains into the Susquehanna and ultimately into the Atlantic ocean, through Chesapeake bay.

The following scheme shows the area of these basins:

Allegheny river basin 955 sq. miles.	Allegheny river sub-basin	425 sq. miles.
	Kinzua creek basin	150 " "
	Tuneangwant " "	135 " "
	Corydon and Sugar creek "	85 " "
	Clarion " "	75 " "
	Tionesta " "	55 " "
	Oswayo " "	30 " "
Susquehanna river basin 25 sq. miles.	Sinnemahoning creek basin	25 sq. miles.

§ 8. The largest basin, which I have called the Allegheny river sub-basin, embraces that area drained by the Allegheny river proper and its tributaries, which flow into the river within the limits of the county. Its area, 425 square miles, includes portions of the following townships: Otto, all of Eldred, Ceres, Bradford, Keating, Annin, Liberty, Hamlin, Sargeant, and Norwich.

The principal streams which flow into the river from the west are Indian creek, Knapps creek, Potato, Skinner and Allegheny Portage creeks. The tributaries coming from the east are smaller and more numerous. Among the largest are Barden, Newell, Rock, Annin, Two Mile, Lillibridge and Coleman creeks.

Potato creek, which empties into the river at Larabees (junction McK. & B. RR. with B. N. Y. & P. RR.) is the largest tributary and drains nearly one half the entire area of the Allegheny sub-basin.

§ 9. *The Kinzua creek basin* has an area of 150 square miles and covers portions of Hamilton, Lafayette, Keating, Wetmore, and, Hamlin. It extends from the center of the county west to the Warren county line. Marshburg is lo-

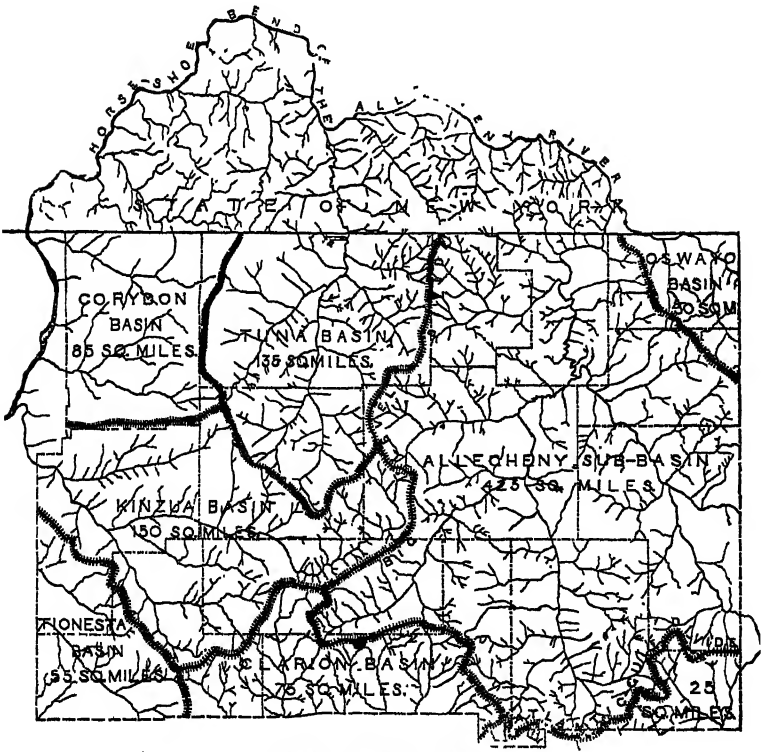
MAP

OF

McKEAN COUNTY,

SHOWING THE POSITION AND AREA OF

THE DRAINAGE BASINS.



Scale: 10 miles=1 inch.

Drawn by A. W. Sheafer. Aid.

cated on the most northern portion of the rim and Kane on the most southern. The principal streams of the basin are Kinzua creek (main branch), which rises east of Alton; Chappel fork heading south of Marshburg and South branch Kinzua creek which heads immediately north and northeast of Kane in Hubert and Glad runs.

§ 10. *The Tuneangwant (or Tuna) creek basin* with an area of 135 square miles covers the greater part of Bradford, about half of Lafayette and the extreme northwestern corners of Keating and Otto respectively. The principal streams are the East branch or Tuna creek, West branch or Tunaette creek, Kendall creek and Foster brook. All of these streams have recently become widely known since the most prominent towns in the *Bradford oil district* have been built up in the valleys through which they flow.

§ 11. *Corydon and Sugar creek basin* embraces all of Corydon and a small portion of western Bradford and northwestern Lafayette. Its area is 85 square miles. It is drained by Corydon and Sugar creeks and Cornplanter run; all flowing west and emptying directly into the Allegheny river.

§ 12. These four basins with that portion of the *Oswayo creek basin* which covers parts of Ceres and Annin townships lie north of the *Kinzua-Emporium anticlinal axis.* The area of this latter basin is about 30 square miles and it is drained by Oswayo creek and its two branches Kings run and Bells run.

§ 13. Only the extreme northern part of the *Clarion basin* lies in McKean. It covers portions of Sergeant, Hamlin and Wetmore and has an area of 75 square miles. Nearly two thirds of Elk county are drained by the Clarion and its tributaries.

§ 14. *The Tionesta basin* occupies parts of Wetmore and Hamilton and is drained by Two Mile run, and east and south branches of Tionesta creek. The area of the basin is 55 square miles.

§ 15. The last and smallest drainage basin of the county is the *Sinnemahoning* which alone sends its waters through the Susquehanna to the Atlantic. Its area of only 25 square

miles covers the southeastern corner of Norwich and small portions of Liberty and Sergeant.

Dividing Ridges.

§ 16. The ridges forming the rims to the drainage basins have very irregular outlines. They are all *very nearly* horizontal; but have a slight progressive dip to the south-west. To a traveler closely following the thickly wooded crest lines of any of these ridges, the levelness of the topography becomes monotonous. I have leveled the crest line from Lafayette to Clermont (25 miles) and its *flatness* impressed me more forcibly than that of the Texan plains.

§ 17. The *Big Level* is the longest divide in the county. It extends from the *Flat Iron Rock*, in Olean township, Cattaraugus county New York, through eastern Bradford, western Keating, central Hamlin and eastern Wetmore townships. This is a portion of one of the the longest dividing ridges in Pennsylvania. After leaving McKean, it passes through the north-western corner of Elk, eastern Forest and north-western Clarion county, terminating in the hill oposite Foxburg, Richland township, Clarion county. Its entire length from Flat Iron Rock to Foxburg is about 100 miles. In various localities throughout its length it is known by different names. In south-western Keating it is called *Ormsby's summit.* From Howard Hill, McKean to Tylersburg, Clarion county it is generally known as the *Big Level* or *Forty Mile Level.* Twenty-five miles of the divide lying between Tylersburg and Foxburg has been named by Mr. Chance the *Allegheny-Clarion Divide.*

The following table shows the height of prominent points of the divide above ocean level.

South of Flat Iron Rock	=2400′
Knapp's creek summit, T. W. P. L. Co.	=2286′
Ormsby's summit	=*2140′**
Howard Hill†	=2268
Glad run summit	=2158′

*All elevations recorded in italics have been determined by aneroid barometer; others by instrumental leveling.

†This greater elevation of the ridge at Howard Hill is caused by the Kinzua-Emporium anticlinal axis.

Clarion summit* (Kane)	=2025′
McKean—Elk county line,†	=1901
Marien	=1715′
Forest—Clarion county line	=1617′
Tylersburg	=1578′
Lickingville	=1580′
Jamestown	=1539′
Hill opposite Foxburg	=1500′±

Most of these summits, whose height has been noted, are capped either by the upper part of the *Pottsville conglomerate No. XII* or the lower part of the *productive coal measures;* so that the elevations given indicate a very important fact: the south-western dip of the rocks.

The width of the *Big Level* varies, ranging from a quarter of a mile to four or five miles.

§ 18. The *Appalachian divide*, next to the Big Level, is the most important in McKean county. It separates the Sinnemahoning creek basin from the Clarion basin and Allegheny sub-basin. Its length from where it enters McKean, from Potter, to where it crosses the line into Elk county is about 20 miles. At McGraw hill near the head of the Saltworks branch Sinnemahoning Portage creek (see plate XIV) the divide is 2220′ above ocean; at Havens brook sumit it is *2140′*.

§ 19. The remaining divides are short in comparison with the above. They have a general east and west direction. In height they vary but little from the elevations already given.

Railroad Communications.

§ 20. There has possibly been more prospective railroad construction in McKean, than any other county in the State of Pennsylvania.

A new project has been put on foot, for a railroad, almost annually, since preliminary lines were run for the Philadelphia and Erie RR. in 1835 by Col. Jarrett.

The greatest difficulty, which has combatted the engi-

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* Final profile P. & E. RR., see page 12.

†All the elevations south of Kane have been taken from the profile of the proposed narrow gauge railroad from Shippensville to Kane.

neer, has been to get over the high summits separating the northern from the southern part of the county. In height they range from 2100 to 2200 feet. This would necessitate a choice between long, circuitious routes or high grades. The economical part of the problem has never been satisfactorily solved.

The railroad locations and connections have been such that it is an easy matter to get *around* the county but a very difficult one to get *through* it.*

The Philadelphia and Erie RR. crosses the south-western corner of the county. The highest summit on this road is less than a mile east of Kane, where the tract lies at an elevation of 2025 above tide. (See profile.)

The Buffalo, New York and Philadelphia RR. crosses the eastern portion of the county. It connects at Emporium with the P. & E. RR.; at Larabee with the McK. & B. RR. at Eldred with the K. & E. RR. and at Olean with the N. Y. L. E. & W. RR. and the O. B. & W. RR. Its summit is at Keating station, Potter county; 1876 feet above tide.

The McKean and Buffalo RR. leaves the B. N. Y. & P. RR. at Larabee and ascends (south) the Potato creek and Red Mill brook to the Clermont coal basin. The object of its construction was to afford an outlet to the tract of the Buffalo Coal Company. It is proposed ultimately to extend this road south into the coal field of Jefferson county.

All of these roads are of the standard gauge 4 ft. 8½ in.

§ 21. The Buffalo, Bradford and Pittsburgh RR. or the Bradford branch of the N. Y., L. E. and W. (Erie) RR., leaves the latter road at Carrollton and follows the Tuna creek south to Buttsville, on the south-eastern rim of the

* During the year 1877 I found, paradoxical as it may seem, that the most central place for headquarters, in making my McKean examinations, was Olean at the intersection of the Erie and Buffalo, New York and Philadelphia RR's. When established at Kane, my quickest and most economical route to Buttsville (13 miles, in an air line, to the north-east) was to go by rail west to Warren, thence north to Jamestown, New York, thence east to Carrollton and finally south to Buttsville; a total distance of 117 miles. When I was not encumbered by instruments or specimens the chosen route was by foot, a distance of 16 miles.

Alton coal basin. A location for the extension of this road south into Elk and Jefferson counties, has been made by Mr. Oliver W. Barnes, civil engineer, and it is proposed to commence construction at an early day.

The gauge of this road, at present, is 6 feet.

§ 22. The Olean, Bradford and Warren RR. is a narrow gauge (3 ft.) road and runs from Olean, over the Olean Rock city summit, to Bradford.

The Kendall and Eldred RR. is of the same gauge as the O. B. & W. RR. and runs from Eldred to Bradford. Both of these latter railroads run directly through the Bradford oil district.

A number of narrow gauge roads have been projected in the vicinity of the oil district but none of them are at present under construction.

Elevations above Tide.

§ 23. The surface heights in the county have a range of one thousand, two hundred and fifty feet (1250′±). The lowest is where Kinzua creek crosses the McKean-Warren county line at an elevation of about 1240 feet; the highest point is Prospect Hill, 2¼ miles east of Smethport Station, the elevation being *2500* feet above ocean. Most of the hills which skirt the larger valleys range in height from 500 to 600 feet.

The accompanying tables of levels give the heights of prominent points above mean Atlantic Ocean level.

§ 24. The entire profile of the Philadelphia and Erie RR. is given. This is the final and accepted profile of the road.

NOTE.—All the elevations given in the tables have been reduced to the datum of the final profile (1879) of the Philadelphia and Erie RR. Many of these levels will be found to disagree with those published on the maps and sections accompanying this report, which latter have been based on the levels published in report N. The profile of the P. & E RR. was not received until the latter part of January 1880, after all the illustrations of report R had gone through the press. No attempt has been made to verify the several profiles. Certain inconsistencies exist which it is imposible to illiminate without going over in the field some of the lines, whose accuracy seems to be doubtful. It was thought best to reduce all the lines to a common datum; if they are correct, all the heights are comparable; if errors exist, they are more easily detected.

Philadelphia and Erie Railroad.

Distance from Sunbury.	Stations.	High tide, Philadelphia.	Mean Atlantic ocean level.
Miles		*Feet.*	*Feet.*
	End of P. & E. RR.,*	438.50	445
0	Sunbury,	440.09	447
	Junction Sunbury, Hazleton and Wilkesbarre RR.,†	447.09	454
2	Northumberland, *Junction of Lackawanna and Bloomsburg Division, D. L. and W. RR.,*	450.20	457
	Kapp's,	452.17	459
9	Montandon,	457.04	464
	Junction Lewisburg and Tyrone RR.,	457.48	464
12	Catawissa RR. Crossing,	464.45	471
13	Milton,	468.65	476
	Brown's,‡	465.86	463
17	Watsontown,	475.58	482
19	Dewart,	480.89	488
	Catawissa RR. Crossing,	484.56	491
24	Montgomery,	484.41	491
28	Muncy,	513.43	520
	Loyalsock Siding (center),	513.01	520
	Montoursville Old Siding (center),	515.57	522
	Allen's,§	519.29	526
	Catawissa RR. Crossing,	525.01	532
	Williamsport (Penn street),	521.39	528
40	Williamsport,	521.30	528
	Junction Elmira Division N. C. R. W.,	525.90	533
42	Newberry,	523.91	531
45	Linden,	528.12	535
	West end Linden Line,	530.73	538
46	Susquehanna,	529.23	536
52	Jersey Shore,	588.36	595
	Bard's Siding (center),	547.78	555
57	Pine,	559 19	566
60	Wayne,	566.10	573
	Bald Eagle Valley RR.,‖ Junction,	550.73	558
65	Lock Haven,	551.63	559
	Lock Haven headblock, west end of yard,	556.83	564
69	Queen's Run,	576.95	584
70	Farrandsville,	575.56	582
71	Graham's Siding (center),	572.36	579
75	Ferney,	587.98	595
78	Glen Union,	597.68	605
80	Whetham,	611.71	619
82	Ritchie,	624.82	632
86	Hyner,	636.64	644

NOTE.—*The levels were run in July, 1879, by Mr. Welch of Lock Haven; the elevations here given will replace those already published in report N, pages 139 to 145.*

* Opposite southern face of Central Hotel.

† Dispatcher's office.

‡ Road crossing.

§ Eastern connection Linden Line.

‖ Eastern connection with P. & E. RR.

89	North Point,	650.46	657
92	Renova,	664.98	672
98	Westport,	683.71	691
102	Cook's Run,	701.71	709
105	Keating,	711.74	719
107	Wistar,	730.75	738
110	Round Island,	747.79	755
114	Grove,	764.19	771
117	Sinnemahoning,	786.90	794
	Junction Low Grade Division, A. V. RR.,	805.82	813
120	Driftwood,	808.42	815
124	Huntley,	848.54	855
129	Sterling,	906.81	914
133	Cameron,	955.49	962
138	Buffalo, New York and Philadelphia RR. Junction,	1012.22	1019
139	Emporium,	1024.32	1031
141	West Creek,	1067.13	1074
144	Howard's,	1154.55	1161
147	Beechwood,	1245.57	1252
150	Rathbun,	1309.58	1316
	West Creek Summit,*	1688.22	1695
159	St. Mary's,	1660.204	1667
162	Scahonda,	1512.35	1519
165	Daguscahonda,	1470.66	1478
168	Shawmut,	1419.08	1426
169	Ridgway,	1386.09	1393
173	Whistletown,	1407.42	1414
177	Johnsonburg,	1433.92	1441
178	Rolfe,	1438.73	1446
180	Clarion,	1474.75	1482
184	Wilcox,	1519.86	1526
187	Dahoga,	1593.98	1601
189	Sergeant,	1708.69	1716
	Clarion Summit,	2018.37	2025
193	Kane,	2013.01	2020
	Cumming's Siding (center),	1870.63	1878
198	Wetmore,	1800.64	1808
	May's Siding (center),	1732.07	1739
202	Ludlow,	1596.76	1604
206	Roystone,	1411.08	1418
209	Sheffield,	1332.	1339
212	Tiona,	1355.11	1362
215	Clarendon,	1382.73	1390
216	Stoneham,	1349.84	1357
	Ott's,	1191.35	1198
222	Warren,	1188.26	1195
	Wiler's, Siding (center),	1183.39	1190
	Brokenstraw Siding (center),	1164.69	1172
228	Irvineton,	1161.19	1168
	Pittsburgh, Titusville and Buffalo RR. connection,	1161.59	1168
230	Youngsville,	1203.80	1211
	Dunkirk, Allegheny Valley and Pittsburgh RR., Crossing,	1203.74	1211
234	Pittsfield,	1234.08	1241
238	Garland,	1301.75	1309
	Garland Quarry,	1322.35	1329
241	Horn's Siding (center),	1364.	1371
244	Spring Creek,	1388.48	1395
249	Columbus,	1400.19	1407
	Atlantic and Great Western RR. Crossing,	1419.82	1427
251	Corry,	1438.09	1445
	Buffalo, Corry, and Pittsburgh RR. Crossing,	1432.78	1440
254	Lovell's,	1367.43	1374
256	Elgin,	1377.95	1385

* Base of south rail of south track.

	Reilly's Siding (center),	1339.96	1347
261	Union,	1262.97	1270
265	LeBœuff,	1211.09	1218
269	Waterford,	1184.92	1192
275	Jackson's,	1220.35	1227
278	Langdon's,	1127.97	1135
280	Belle Valley,	998.68	1006
	Lake Shore and Michigan Southern RR. Crossing,	678.50	685
288	Erie,*	577.76	585

The datum or base of levels is that of the Pennsylvania RR. (main line). According to Mr. James T. Gardner's determination, this datum, which is ordinary high water in the Schuylkill river, is 6.913 feet above the mean surface of the Atlantic ocean. This difference in data has been added to the elevations in the first column to obtain those given in the second. In this latter column decimal parts of a foot do not occur. When below .5′ they have been omitted; when above .5′, a whole number has been substituted.

§ 25. *Buffalo, New York and Philadelphia RR.*

Distance from Emporium Junction.	STATIONS.	Profile.	Above tide, P. & E. RR. correction.
Miles.		*Feet.*	*Feet.*
0	Emporium *Junction with P. & E. RR.,*	448	1019
8	Shippen,	630	1201
16	Keating (summit),	1305	1876
21	Liberty,	1070	1641
24	Port Allegheny,	906	1477
31	Sartwell,	876	1447
33	Larabees,	905	1476
	McKean and Buffalo RR. Junction,	901	1472
37	Eldred,	867	1438
41	State Line,	867	1438
45	Portville,	866	1437
51	Olean,	859	1430
52	*Olean Junction N. Y., L. E. & W. RR.,*	862	1433†
121	Buffalo,	11	582

NOTE.—For elevation of stations between Olean and Buffalo see Report N, page 98.

* Frog Point at east end of old freight house.

†According to profile of the N. Y., L. E. and W. (Erie), RR. Olean junction is 1438 above mean Atlantic Ocean level. (See Report N, page 98.)

§ 26. *McKean and Buffalo RR.*

Miles.		Feet.	Feet.
	Buffalo, New York and Philadelphia RR. Junction,	873.	1172
0	Larabee's,	871 50	1470
2	Frisbee,	860.50	1459
5	Farmer's Valley,	871.50	1470
9	Smethport,	889.06	1488
14	Crosby,	936.30	1535
15	Colegrove,	938.80	1538
16	Hamlin,	953	1552
20	Wernwag,	1256.50	1855
22	Clermont *Bishop's Summit*,	1469.50	2068*

§ 27. *Buffalo, Bradford and Pittsburg RR.*

Bradford Branch; New York, Lake Erie and Western RR.

Distance from Carrollton.	Stations.	Above tide Erie RR. datum.	Above tide P. & E. RR. correction.
Miles.		Feet.	Feet
0	Carrollton; *Junction N. Y., L. E & W. RR.*,	1399	1394
6.2	Limestone,	1410	1405
7.9	State Line,	1419	1414
8.4	Babcock,	1419	1414
10.1	Tarport or Kendall creek,	1438	1433
11.5	Bradford,	1444	1439
14.2	De Golier,	1501	1496
17	Lewis Run,	1559	1554
19	Big Shanty,	1666	1661
22.3	Crawford's,	1959	1959
	Summit,	2138	2133
25.2	Alton,	2087	2082
	Bond Vein (Gilesville),	2055	2050
	Buttsville,	2014	2009

The above profile was obtained from Mr. John M. Finch, General Land Agent at Hornellsville (see report N, page 103.) There is evidently an error in that portion of the profile south of De Golier.

The following table gives the results of my telemeter and vertical arc measurements between De Golier and Buttsville; these I consider more reliable than the elevations of the profile furnished by Mr. Finch.

*The elevation of Clermont on the Topographical map of the Buffalo Coal Company's tract is given 2074, see page 125 and report N, page 156.

STATIONS.	Above tide Erie RR. datum	Above tide P. & E. RR. correction.
De Golier,	1501	1496
Lewis run,	1565	1560
Big Shanty,	1672	1667
Alton,	2072	2067
Bond Vein,	2030	2025
Buttsville,	1999	1994

§ 28. *Western Division, New York, Lake Erie and Western (Erie) RR.*

Distance from New York.	STATIONS.	Above tide,*	Above tide P. & E. RR. correction.
Miles.		*Feet.*	*Feet.*
393	Olean; *Junction B. N. Y. & P. RR.*,	1438	1433
397.8	Allegheny,	1422	1417
402	Vandalia,	1415	1410
406.8	Carrollton; *Junction Bradford Branch, B. B. & P. RR.*,	1399	1394
410.2	Great Valley,	1393	1388
413	Salamanca,	1384	1379
420.5	Little Valley,	1594	1589
459	Dunkirk,†	600	595

§ 29. *Pennsylvania and Erie R'wy.*

Wilcox Elk Co. to Buttsville McKean Co.

St. John's proposed line.

STATIONS.	Profile.	Above tide. P. & E. R R. correction.
Wilcox, *north end of P. & E. RR. bridge,*	100	1526
County line crossing,	179.06	1605
Lanigan run,	208.46	1634
Schultz gas well, Wilcox well No. 2,	221 ±	1646
Clarion crossing,	308 ±	1734
Crossing Kane and Howard Hill road,	770.50	2196
Howard Hill hotel,		2225±
Elevation surface of creek at Kinzua crossing,	370.56	1796
Switch in front of engine-house at Buttsville,	570.29	1996

*The datum is tide water at Jersey City. This, if *mean tide*, may be considered equivalent to ocean level.

†The elevation given at Dunkirk by Lake Shore and Michigan Southern RR., is 24.94+573. Lake Erie=597.94. (Report N, page 220.)

§ 30. *McKean County Crest Line.*

(*Surveys of Gen. Thos. L. Kane.*)

Locality.	Station.	Profile.	Dalson's datum.	Ocean level.
		Feet.	*Feet.*	*Feet.*
Dalson's Bench, Howard Hill,	.	420.32	2222.5	2249
Center of Big Level (State) road, Howard Hill,	542+80	392.70	2194.9	2222
Seven mile Summit,	331	370.55	2172.7	2200
Crossing of Wilcox and Smethport State road,	318+66	356.79*	2159	2186
	1	256.79	2159	2186
B. M. on Hemlock stump, Marvin Summit, on Wilcox and Smethport (Hamlin) State road,	16	280.19	2182.4	2209
Sugar Maple, *N. W. corner warrant 2496,* (tree *blown down,*)	60	229.22	2131.4	2158
Creek on north boundary line, warrant 2496,	64	198.44	2100.6	2128
Point north of Kathrine swamp,	77	292.27	2194.4	2221
Head of west branch of Warner brook,	97	281	2183	2210
First Summit, *between Ginalsburg and Warner brook.* Note.—*This summit is about 200 feet wide, and slopes 10 degrees each way,*	113	221.67	2123.8	2151
Second Summit, *between Ginalsburg and Warner brook,*	117	212.28	2114.5	2141
Third Summit, *between Ginalsburg and Warner brook,*	122	210.21	2112.4	2139
Fourth Summit, *between Ginalsburg and Warner brook,*	126	191.34	2093.5	2120
Summit, *between Martin's run and Warner brook,*	153	171.24	2073.4	2100
Burlinghame Summit, *between Ginalsburg and Warner brook,*	165	163.30	2065.5	2092
Old Stump, Bishop's Summit,	168	171.01	2073.19	2100

§ 31. *Howard Hill to Johnsonburg.*

Locality.	Station.	Profile.	Dalson's datum.	Ocean level.
		Feet.	*Feet.*	*Feet.*
Dalson's Bench, Howard Hill,	. . . .	420 32	2222.5	2249
Top of post on highest point of Howard Hill,	. . . .	425.48	2227.7	2255
Center of Big Level (State) road, Howard Hill,	548+80	392.70	2194.9	2222
Toby waters,	482+	355.17	2157.3	2184
Do. do.,	481+	355.27	2158.4	2185
Second Cold spring in notch, Marvin waters,	441	364.91	2167.1	2194
First Cold spring in notch, Marvin waters,	429	377.40	2179.6	2207
Seven Mile Summit,	331	370.55	2172.7	2200

* This elevation, given on the profile of the line from Howard Hill to the Wilcox-Smethport road, is 100′ higher than the elevation of the same point given on the profile of the line from the Wilcox-Smethport road to Bishop's Summit.

Crossing of Wilcox and Smethport State road,	318+66	356.79	2159	2186
About narrowest point between Rocky run and Seven Mile run, ...	253	294.42	2096.6	2124
Shaddock's road, *sometimes called "Old Marvin road,"*	221	299.79	2102	2129
Notch south of Shaddock place, ...	211	283.09	2085.3	2112
Barnes road, between Barnes and Williamsville, ...	130	263.74	2065.9	2093
Eight Mile Spring, ...	107	215.24	2017.4	2044
Eight Mile Summit, ...	95	203.99	2006.2	2033
Bench *on Joe Pistner Summit,*	69	162.76	1964.9	1992
Bench mark on *Hemlock Post, Weidert's Summit,*	0	100	1902.2	1929
Weidert's Summit to Cobb's Bridge.				
Weidert's Summit, ...	. . .	328.12*	1902.2	1929
Top of post north of John Weidert's	70	278.42	1852.5	1879
Corner of Bonnett's garden, ...	48	356.52	1930.6	1958
Pistner coal opening, ...	42	325.66	1899.7	1927
Water at Pistner run, in St. Mary's road, . .	29	200.50	1774.6	1802
Junction of St. Mary's road and road leading to Cobb's bridge, ...	7	161.81	1735.4	1762
B. M. on root at Cobb's Bridge over Johnson's run, ...	0	100	1674.1	1701
Cobb's Bridge to Johnsonburg.				
Line at Cobb's Bridge, ...	. . . .	360.90†	1674.1	1701
Water at Cobb's Bridge, ...	. . . .	350.97	1664.1	1691
Mouth of Sweet's run, ...	70	313.33	1626.5	1653
Mouth of Luce run, ...	50	215.87	1529	1556
B. M. 1156, B. & B. RR. line, *mouth of Johnson run,*	39	165.30	1478.5	1505
Mouth of Johnson run, (*water?*)	37	148.66	1461.8	1489
Crossing of Laurel run, ...	22	141.25	1454.4	1481
Mouth of Laurel run, ...	19	117.85	1431	1458
Bridge seat at Johnsonburg, *over Clarion river, P. & E. RR.,*	1	94.44	1407.6	1435

§ 32. The elevations given in the following tables were determined by my aid Mr. A. W. Sheafer with a Hicks' aneroid borometer. The observations were made with great care and subjected to numerous checks.‡ Many barometric heights, other than those given in the tables, were determined. They were obtained in order to assist in mapping the geological outcrops. As many of the points are not suffi-

* This elevation, given on the profile of the line from Weidert's Summit to Cobb's Bridge, is 228.12 feet higher than the elevation of the same point given on the profile of the line from Howard Hill to Weidert's Summit.

† This elevation, given on the profile of the line from Cobb's Bridge to Johnsonburg, is 260.90 feet higher than the elevation of the same point given on the profile of the line from Weidert's Summit to Cobb's Bridge.

‡ It is believed the limit of error in any one case would not exceed 15 to 20 feet.

ciently prominent to be easily described or recognized the elevations have not been tabulated.

§ 33. Elevations in Alton, Howard Hill, Clermont and Potato creek coal basins, have been placed directly upon the topographical maps of these areas and are therefore not reproduced in tables.

§ 34. *Wetmore Station, P. & E. RR., to Kinzua Village.*

LOCALITY.	Above tide.	Above tide P. & E. RR. correction.
	Feet.	*Feet.*
Wetmore,	1804	1808
Crossing Two Mile run Sec. 298, War. 2395,	*1745*	*1749*
Crossing of stream north part of Sec. 267, War. 2563,	*1850*	*1854*
Crossing of stream N. E. cor. Sec. 258, War. 2563,	*1915*	*1919*
Old Log Shanty Sec. 186, War. 2575,	*2027*	*2031*
Crossing of stream at G. Bliss',	*1365*	*1369*
Forks of Kinzua creek,	*1300*	*1304*
Bridge over Kinzua creek,	*1300*	*1304*
Junction Lafayette road,	*1385*	*1389*
Crossing of Lightening run,	*1365*	*1369*
Road, crossing stream emptying into Morrison's saw mill dam,	*1315*	*1319*
Morrison's saw mill dam,	*1260*	*1264*
Bridge over Chappel fork,	*1265*	*1269*
Bridge over stream at S. H. No. 1, War. 2376,	*1270*	*1274*
D. Louck's Oil well, War. 2376,	*1295*	*1299*
Kinzua creek at county line,	*1240*±	*1244*
Kinzua Village (B. M., H. M. Chance,)	1231	1235

§ 35. *Forks of Kinzua creek to Kane.*

LOCALITY.	Above tide.	Above tide P. & E. RR. correction.
	Feet.	*Feet.*
Forks of Kinzua creek,	*1300*	*1304*
Bliss War, 2853,	*1365*	*1369*
Bridge over Mud Lick run,	*1435*	*1439*
Crossing of Bloody Lick run,	*1465*	*1469*
Sulphur Spring,	*1615*	*1619*
Kane,	2016	2020

§ 36. *Smethport to Warrant 2060.*

Smethport Station,	1493	1488
Junction of roads at S. H. No. 2 War. 2064,	*1522*	*1517*
" " " E. line of " 2058,	*1529*	*1524*
Summit at A. Matthew's, N. W. cor. War. 2060,	*2384*	*2379*

§ 37. *Smethport to Port Allegheny.*

Smethport Station,	1493	1488
Road forks at S. H. No. 2,	*1522*	*1517*
" " near W. Grifford's, War. 3064,	*1648*	*1643*
Summit near road S. E. cor. War. 2083,	*2145*	*2140*
Road forks S. E. cor. 2081,	*2140*	*2135*
Summit south of A. Camell's War. 2063. HIGHEST POINT IN MCKEAN CO.,*	*2500*±	*2495*
Devil's Elbow, War. 2063,	*2065*	*2060*
Road forks on Open brook, War. 2060,	*2020*	*2015*
Crossing E. line of War. 2081,	*1862*	*1857*
Crossing of stream S. W. part of War. 2073,	*1730*	*1725*
" " " at A. Sherwood's, War. 2073,	*1665*	*1660*
Road forks E. part of War. 2073,	*1610*	*1605*
Junction with river road War. 95,	*1513*	*1508*
Port Allegheny Station,	1482	1477

§ 38. *Port Allegheny to Ceres.*

Port Allegheny Station,	1482	1477
Turtle Point, bridge over Rock run, War. 115,	*1450*	*1445*
School House, War. 2213,	*1615*	*1610*
Road forks near P. Bliss, War. 2177,	*1835*	*1830*
" " N. E. cor. War. 2220,	*2190*	*2185*
" " N line " 3447,	*1620*	*1615*
Road at S. H., No. 5, Ceres township,	*1705*	*1700*
Crossing King's run, War. 4327,	*1495*	*1490*
Junction with road from Eldred, War. 4327,	*1525*	*1520*
Junction with road to State Line P. O., War. 4326,	*1475*	*1470*
Ceres Hotel,	*1460*	*1455*

§ 39. *Ceres to Eldred.*

Ceres Hotel,	*1460*	*1455*
Junction of road to Turtle Point, War. 4327,	*1525*	*1520*
Road forks south part War. 2230,	*1563*	*1558*
Eldred,	1443	1438

§ 40. *Port Allegheny up Lillibridge creek.*

Port Allegheny,	1482	1477
Crossing of stream western part of War. 2150,	*1545*	*1540*
Crossing of stream, War. 2180,	*1612*	*1607*
School House, S. E. cor. War. 2168,	*1705*	*1700*
Crossing of stream near J. Ames, War. 2236,	*1775*	*1770*

* Prospect Hill is not only the highest point in McKean county but is the greatest elevation in Pennsylvania west of the Fifth Coal Basin.

§ 41. *Turtle Point to Annin P. O.*

Turtle Point,	1456	1451
Junction of road to Port Allegheny,	*1464*	*1459*
Road at Bessie's, S. W. cor., War. 2228,	*1550*	*1545*
" Cooper's saw mill, S. W. part War. 3444,	*1670*	*1665*
M. E. church, War. 3444,	*1745*	*1740*
Road forks, Annin P. O.,	*1728*	*1723*
" " War. 2203,	*2260±*	*2255*
" " " 2207,	*1830*	*1825*
Crossing of stream W. part War. 2168,	*1635*	*1630*
Junction of Two Mile road with Port Allegheny road, War. 3454,	*1450*	*1445*

§ 42. *Port Allegheny to Norwich P. O.*

Port Allegheny,	1482	1477
Bridge over Portage creek, W. part War. 1858,	*1490*	*1485*
Crossing of stream S. E. part War. 2053,	*1585*	*1580*
" " N. W. cor. War. 2327,	*1665*	*1660*
Crossing of Comes creek,	*1765*	*1760*
Bridge over Walcott creek, War. 2393,	*1790*	*1785*
RR. at road crossing, N. W. cor. War. 2557,	*1536*(?)	*1525*(?)
Colgrove Station,	*1543*	*1538*
Norwich cross roads,	*1605*	*1600*
Road forks at J. B. Kimball's,	*1625*	*1620*

§ 43. *Wilcox Well, No. 2, to Seven Mile Summit, to Williamsville.*

Wilcox Well, No. 2, (Schultz Gas Well,)	*1642*	
Bridge over stream, War. 2723,	*1772*	
Road forks, N. W. cor. Sec. 279, War. 2436,	*2200*	
" " Seven Mile Summit,	*2164*	
Turn in road near cleared field, War. 2426,	*2095*	
School House, Sec. 292, War. 2426,	*2050*	
Bridge over Rock run, War. 2345,	*1900*	
Junction Five and Seven Mile runs,	*1674*	

Chapter II.

§ 44. Surface geology; § 45. Soils; § 46. Forest and Timber lands; § 64. Palæontology.

Surface Geology.

§ 44. The drift areas of the county are so covered with soil and vegetation, that sufficient facts have not been gathered to warrant an exposition of the features of its surface geology.

There is still considerable doubt as to the influence which the ice sheets of the glacial period, have had in determining the contour of its valleys and hills. The position and direction of flow of the streams remain the same as they were prior to the ice age; but the levels at which the stream beds at present are found are quite different. This fact is proved by the thickness of the drift beds in the bottoms of the valleys.

The drift in the northern part of the county is very much thicker than it is in the southern.

In the Olmsted well No. 3, on the Clark farm at Tarport, pipe was driven through 253 feet of the drift clays, sands and gravels, before the bed rock was struck. On the Glass farm at State line 250 feet of drift was encountered in the wells.

The character of the drift is not known, as no record has been reported of the variety of beds pierced. All the valleys north of Kinzua creek have been filled up by drift; in none of them is the drift of as great thickness as in the Tuna valley. As there are no evidences that the surface of McKean has subsided to permit the valleys to be filled up, the facts argue a different and lower outlet to the drainage of the county. From a survey of the facts presented in Report III, it seems now quite certain that that portion

of the Allegheny river basin north of Kinzua village, drained into Lake Erie near Dunkirk instead of as at present, through the western part of the State and ultimately into the gulf of Mexico.

When the river cut its way through the hills below Kinzua village, and the old northern outlet was filled up, immense areas were flooded and covered with water, which before were dry land. The result was, that as erosion continued and the rocks of the hills were broken up and washed into the valleys they became gradually filled up and the depth of the streams constantly diminished, until attaining their present shallowness.

The boulders and pebbles found in the drift are very small and are derived, as far as observed, entirely from sedimentary rocks. Many of them are fossiliferous and have come from the strata of the lower Carboniferous or upper Devonian age.

Immediately north of the State line a greater variety of pebbles are found. These latter are derived from granite, gneiss and other varieties of crystalline rocks; beside limestone, sandstone, shale and sometimes even coal and coal slates. The absence of large boulders in the drift, is proven by the fact that in driving the "*drive pipe*" for the oil wells boulders are *very seldom* encountered, which cannot be forced aside by the comparatively frail 8 inch iron pipes used to pierce the drift.

In the southern part of the county there is much less drift in the valleys. It rarely exceeds 40 to 50 feet. In the valley of the Clarion west branch, at the Wilcox well No. 3 a careful record was keep of the successive layers, which were as follows:

1. Loam and sand,	5′
2. Loam and gravel,	5′
3. Gravel and pebble,	10′
4. Gravel and sand,	5′
5. Gravel and pebble,	5′
6. Gravel and sand rock,	5′
7. Quicksand and coarse pebble,	5′
8. Fine sand,	3′
	43

The prevailing trees are: 1. Hemlock spruce; 2. White pine; 3. Beech; 4. Cucumber tree; 5. Wild cherry; 6. Maple; 7. Poplar, and 8. Oak; occasionally, 9. Chestnut; 10. Birch; 11. Ash, and 12. Willow.

The undergrowth is made up mostly of 13. Laurel; 14. Rhododendron, and 15. Hazel.

The following brief statement gives, in a general way, some facts concerning each species enumerated above, and at the same time the relation noticed between the kind of wood and the kind of rock upon it is generally found growing.

§ 47. Hemlock spruce (*Pinus Canadènsis.*)

Height 60 to 90 feet.

Diameter 2 to 3 feet.

Grows on hillsides, plateaux, and sometimes along the rocky banks of streams.

The tree seems to be more abundant and grows larger on the high levels than on the hill slopes; this may be only apparent as the trees have been more extensively *lumbered* along the hill slopes and water courses. The roots keep very near the surface of the soil; seldom penetrating to a greater depth than 1½ to 2 feet. I have seen the roots of hemlocks, which have been blown down, stand 15 feet high. The tree seems to thrive in almost any kind of soil and upon almost any kind of rock.

The hemlock supports almost entirely the lumbering business of the district, besides supplying all the bark for the tanneries of this section of the State.

§ 48. White pine, sometimes called Weymouth pine, (*Pinus Strobus.*)

Height 80 to 110 feet.

Diameter 1 to 3 feet.

Generally found growing in good soil, and seems to prefer cool, damp, and slightly marshy localities. The tree has been quite abundant, but has been rapidly destroyed from extensive lumbering. The largest pine groves in the county seem to have existed in the eastern part, in the valley of the Allegheny.

I do not remember to have seen any quantity of yellow

pine (*pinus mitis*); in fact the white pine seems to exist to the exclusion of the other varieties. An estimate made at the time that the pine lumber trade was at its height in McKean and Potter counties, placed 10,000 feet of lumber to the forest acre.

§ 49. Beech.

Height 30 to 50 feet.

Diameter 1 to 1½ feet.

The beech is generally found growing in the more fertile soils, or that which is formed by the sand shales which are slightly calcareous. As a rule the tree does not thrive on the very sandy and stony areas. The coal measures above the OLEAN CONGLOMERATE, No. XII seem to produce a soil more favorable to the growth of the beech than any of the outcropping rocks. The tree does not grow as large as in the southern and eastern parts of the state.

§ 50. Cucumber tree somtimes called the *common cucumber magnolia.* (*Magnolia acuminata.*)

Height 50 to 70 feet, sometimes more.

Diameter 3 to 4 feet. The diameter seems to be greater in proportion to its height than in either the hemlock spruce or white pine. The tree at present is not very abundant. The manufactured lumber ranks in the trade with popular.

The grain of the wood resembles somewhat that of basswood (*Tilia*) but takes a finer polish on working; this fact is possibly due to a greater compactness of grain. The tree seems to grow on the more fertile and less sandy soils.

An allied species is said to grow in north-western Pennsylvania the *umbrella magnolia.* I have never recognized this tree in my district.

§ 51. Wild cherry or black cherry (*Prunus Serotina*).

Height 30 to 50 feet, sometimes 80 feet.

Diameter 1 to 3 feet (more or less).

The tree is frequently found in groves and would seem to prefer a rather moist fertile soil.

§ 52. Maple (*Acer*). There are several varieties of maple within the county, only two of which I have noticed, the rock or sugar maple and the common maple, which I believe to be the stripe maple. The former species attains a larger

county renders lime an expensive fertilizer. To return a profit to the farmers, the lands must be more generally manured and *kept up* than they have been in the past.

The policy, which has been pursued by agriculturists in McKean of attempting to put under cultivation large areas, is a bad one and has generally met with disappointment and failure. After the land has been cleared and produced one or two crops, it becomes necessary to fertilize it; where the amount of territory worked is large in proportion to the stock raised and means to procure manure the land is generally abandoned from its *worked out* condition, after two or three years of unsuccessful farming.

Latterly a more thrifty and economical class of settlers have come into the county and commenced operations on a more contracted basis; clearing the land gradually and at the same time *keeping it up*.

The Swedish settlements on the *Big Level*, which have been organized and fostered by General Thomas L. Kane afford a striking illustration of this better method of farming.

Grass grows well in most parts of the county and I believe the land is better suited to stock raising and grazing than for any other purpose. The more fertile areas, by careful and judicious farming should more than furnish all supplies necessary for supporting a population, required to cultivate the farms and care for the stock; so that properly conducted the balance of the agricultural trade should always be in favor of McKean county.

Forests and Timber Lands.

§ 46. Within the limits of the county considerable variety of trees and undergrowth are found, in the dense forests for which this portion of the State has long been famed. The character of the forest growth in McKean does not differ materially from that to be found in the adjoining counties; so that a general description of the woods of McKean will apply *equally* to the counties of Cameron, Elk, and Forest.

The prevailing trees are: 1. Hemlock spruce; 2. White pine; 3. Beech; 4. Cucumber tree; 5. Wild cherry; 6. Maple; 7. Poplar, and 8. Oak; occasionally, 9. Chestnut; 10. Birch; 11. Ash, and 12. Willow.

The undergrowth is made up mostly of 13. Laurel; 14. Rhododendron, and 15. Hazel.

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growth than the latter and is generally found in groves on the higher levels; while the latter is found more or less in the valleys and sheltered positions.

§ 53. Poplar has a very limited growth in the county. Most of the poplar trees have been lumbered.

§ 54. Oak.

White oak (*Quercus alba*).

Height 50 to 80 feet.

Diameter 1 to 3 feet.

Not very abundant; where it is found, it seems to prefer fertile, damp soils.

Bear or scrub oak (*Quercus ilicifolia*) a struggling scrub tree from 3 to 8 feet high and oftentimes in dense masses. Grows in sandy soils and on rocky hills, sometimes known as the black scrub oak.

Other varieties of this same family doubtless occur in the county but they have not been noted.

§ 55. Chestnut (*Castanea*).

Height 50 to 70 feet.

Diameter 2 to 3 feet.

Not very abundant; grows in fertile soils.

§ 56. Birch.

White birch (*Betula alba*).

Height 20 to 25 feet; seldom more than 6 inches in diameter. Grows in poor soils, both wet and dry.

River birch (*Betula nigra*) and cherry birch also grow to a limited extent within the county.

§ 57. Ash is found in some localities; species unknown.

§ 58. Black willow (*Salix nigra*) has a limited growth. The Beaver meadows, on Kinzua creek, north of Howard Hill, are covered with a growth of willow.

The undergrowth is composed largely of laurel, rhododendron, hazel, and scrub oak, which latter has been already described.

§ 59. Mountain laurel (*Kalmia latifolia*). Height 4 to 10 feet.

Grows on rocky barren soil, either wet or dry, but generally preferring the former. Often times found in swamps.

§ 60. Rhododendron or Great Laurel. *Rhododendron maximum.*) Height from 6 to 12 feet; sometimes as great as 20 feet.

Grows in damp deep woods and swamps.

§ 61. Witch hazel (*Hamamelis Virginiaca*). Shrub from 6 to 12 feet high. Occurs on the borders of marshy woods and on the banks of streams.

§ 62. In ascending a hill capped by the POTTSVILLE CONGLOMERATE, the laurel and hazel growth, particularly the former, oftentimes commences at the change of slope, which is invariably formed by the bottom of the conglomerate. The same shrubs frequently cover the entire escarpment formed by this stratum. This fact has assisted very much in determining the place of the OLEAN CONGLOMERATE in the district. Most of the swamps in the county are immediately underlaid by fireclays.

§ 63. The amount of cleared land in the county has increased very much since the commencement of the Bradford oil development. In December, 1877, I estimated that about one seventh (150 square miles) of the entire area of the county (980 square miles±) was cleared land. Possibly not more than two thirds of this was under cultivation. During the past two years the production of lumber has increased, due to the increasing demand in the oil districts; so that the amount of cleared territory has been sensibly augmented, although there has been but a slight increase in the amount put under cultivation.

Hemlock land will cut on an average 15 cords of bark and 20,000 feet of lumber per forest acre. During the year 1877 it was estimated that the lumber production was about 50,000,000 feet. To produce this lumber and the bark which it has been estimated that the tanneries consumed, about four square miles of forest were cut. Since the beginning of 1878, I have no authentic facts upon which to base an estimate as to the rapidity with which the forests are being destroyed.

Palæontology of McKean County.

§ 64. During a general reconnaissance survey of the county, made in the summer of 1876, a large number of fossil specimens were collected and classified, with a view of determining the position in the palæozoic column, of the rocks of the district.

The outcrops were so few; the variety of species so small; the vertical range of the individuals so great, that no satisfactory conclusions could be arrived at, as to a systematic division of the strata.

After a careful classification of all the facts obtained during this reconnaissance, it was finally decided to group the strata by a study of their lithology, and on this basis to seek to make a connection with sections in those portions of the State where the structure had been clearly defined.

The result of this plan has proved most satisfactory. Since my examinations in Cameron, Elk, and Forest, I feel confirmed as the the correctness of the grouping of the strata which is indicated in this report.*

During the months of July and August, 1878, at my request, Professor L. E. Hicks, of Dennison University, Grannville, Ohio, made a complete collection of fossils in the district. After a careful study of the specimens, the following report was made:

Prof. Hicks' report on fossils.

Characteristic *Chemung* fossils were found in several localities; with the exception of one species of *Dictyophyton*, nothing new, or different was discovered from the abundant fauna and flora of that formation in the adjacent counties of the State of New York, so copiously illustrated by Professor James Hall.

* No *formation names* are placed on the sections, Plate XI. At the time that this sheet was going through the press, I did not believe it advisable to suggest names for the groups which were at that time lettered, group A, group B, and group C. Since then a connection has been made with sections in adjoining counties, so that for A, B, and C can be placed the names *Pocono*, *Catskill*, and *Chemung*, respectively.

In the coal measures, and in the conglomerate series (XII) which underlie them, nothing was observed which calls for special remark unless it be a monstrous Fucoid, remains of which are plenty about Kane. One large fragment having been set up as an ornament or curiosity in front of Mr. Coleman's store.

The interval, of 500 to 800 feet, between the base of No. XII and the rocks below, which contain unmistakable Chemung fossils, represents three distinct strata of eastern Pennsylvania, viz: the Mauch Chunk shales (XI), Pocono sandstone (X) and Red Catskill (IX); unless we assert that these strata, or some of them, are wanting in McKean and Elk counties. Whether they are all represented, and what portion of the interval must be assigned to each, are questions whose answers (if the first is answered affirmatively) must rest upon the stratigraphical evidence; for I am not able, upon paleontological grounds, to draw any subordinate lines within that interval. I am thoroughly convinced that these rocks hold a fauna which is essentially a unit, incapable of subdivision, and that this fauna is decidedly of a subcarboniferous type.

I have collected in this group the following species which are identical with species characteristic of the Waverly group in Ohio:

Lingula melie, Hall; Productus two sp.; Orthis Michelini, Morris; Hemipronites crenistria, Phillips; Chonetes sp.; Spirifer Carteri, Hall; Syringothyris typa, Win.; Athyris lamellosa, Leveille; Rhynchonella Missouriensis; Pterinea sp.; Cypricardia, two sp.; Allorisma sp.; Murchisonia sp.; Platyceras, two sp.; Bellerophon sp.;—in all eighteen Waverly species.

The same rocks contain also the following Chemung species:

Euomphalus depressus, Hall; Pteronites Chemungensis, Hall; Rhynchonella sappho, Hall (Hamilton and Chemung); R. contracta, Hall; Spirifer altus, Hall; S. disjunctus, Hall; and Productella lachrymosa, Hall;—seven Chemung species.

Productus semireticulatus, a carboniferous type, also occurs in this interval.

This list of of species sufficiently exhibits the prevalent subcarboniferous aspect of this fauna. It also shows an intermingling of Chemung with Waverly species which is a striking characteristic of this region of Pennsylvania as compared with the distinctness of Subcarboniferous and Devonian fossils in central Ohio. It would seem that the deposition of sediments in this part of the continent proceeded quietly and somewhat uniformly during the latter part of the Chemung period, and until the epoch of the OLEAN CONGLOMERATE, in an ocean whose shores, currents, sources of sediment, depth, and rate of deposit varied considerably, as is shown by the existence of the Sub-Olean and other conglomerates, and the red rocks, but whose physical conditions nevertheless were marked by such a degree of constancy that the animal life varied slowly, and not from local causes but only in harmony with widespread life-changes, such as mark the transition from the Devonian to the Carboniferous. Hence we should expect the Chemung species to extend upwards and flourish side by side with species which are everywhere recognized as good Subcarboniferous types, just as we actually find them doing.

No animal forms were found other than those enumerated by Prof. Hicks.

Considerable quantities of sea plants and a few forms of of lands plants occur in all the rocks which are exposed from the base of the Pottsville conglomerate down.

Large masses of sea weeds were found especially in the lower part of the Pocono in the northern part of the county.

CHAPTER III.

Geological Structure.

§ *67. Boon's mountain anticlinal;* § *68. Sinnemahoning portage fault;* § *69. Norwich coal basin;* § *70. Norwich anticlinal;* § *71. Clermont coal basin;* § *72. Smethport anticlinal;* § *73. Alton coal basin;* § *74. Kinzua-Emporium cross anticlinal.*

§65. The geologic structure of the district is simple to comprehend and yet difficult to determine.

The conclusions arrived at in this report, are frequently quite different and oftentimes antagonistic to those contained in the final report by Prof. Rogers; and yet, when the difficulties which combat one in studying the geology of McKean county are taken into consideration, I cannot help but admire the wonderful insight which the assistants of the first survey got of the structure, during their hurried reconnaissance survey.

The district is not much less a forest and hardly more settled than it was thirty years ago; but numerous mining explorations have been made, which render a study of its geology much easier.

The entire county is drift covered; the drift varying in depth from 5 to 10 feet on the summits, to 250 feet in the valley of the Tuna below Bradford.*

The rock exposures are *very few* and *very poor* so that the structure could only be determined, by covering the county with a net work of elevations and obtaining a connection between such records of drill holes as could be procured and *blank*† surface sections as could be constructed.

*How deep the drift is in the Allegheny valley below Eldred is not known, possibly about the same as it is in the Tuna valley.

† Sections in which the unknown and concealed intervals far exceed in thickness the exposures, are called *blank* sections.

§66. The county lies in the *Ninth district* or *Bituminous coal region* of the State.* It includes parts of the Fourth, Fifth and Sixth coal basins.

The anticlinal and synclinal axes have nearly a north-east and south-west direction with the exception of the *Kinzua-Emporium cross anticlinal axis*, which runs north-west and south-east.

Commencing at the south-eastern corner of the county, the axes are arranged in the following order:

Boon's Mountain anticlinal (Third) axis,
Axis, Norwich (Fourth Bituminous) coal basin,
Norwich anticlinal (Fourth) axis,
Axis, Clermont (Fifth Bituminous) coal basin,
Smethport anticlinal (Fifth) axis,
Axis, Alton (Sixth Bituminous) coal basin.†

Boon's Mountain anticlinal.

§67. This axis crosses the extreme south-eastern corner of Norwich township, but 1½ miles from the junction of McKean, Potter and Cameron counties. The flexure at this point seems to be sharper and has elevated the strata higher than at other points along its axis. Point Lookout, in Potter county, east of Keating station, is near the anticlinal.

The axis has nearly a due north-east direction in Potter; it passes in the vicinity of the villages of Homer, Sweden and Lewisville. In Harrison township it broadens out and becomes quite flat, with low dips on either side. It enters New York near the north-western corner of Tioga county.

To the south-west of Keating station the axis has an unbroken course to the Driftwood branch of Sinnemahoning creek where it breaks, along the Kinzua-Emporium cross anticlinal axis. This same flexure is found to commence again at the *Emporium dome.* From here its direction is parallel to its former course and it enters Elk county at the junction of Benzinger, Jay and Benezette townships, passing through the center of Boon's Mountain.

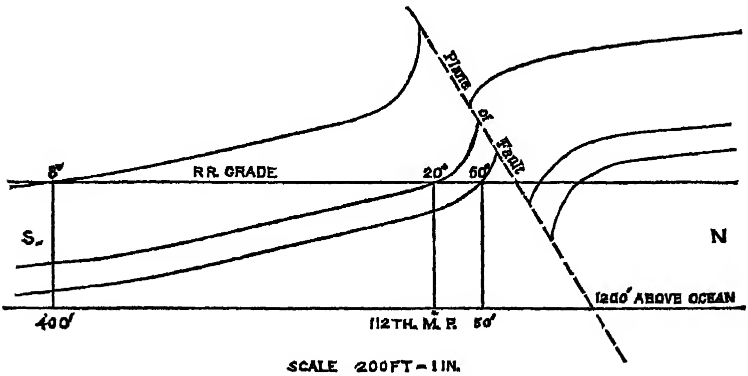
* Rogers' final report, vol. 1, page 119.

† The position of this latter synclinal axis is not shown on the county geological map.

Sinnemahoning Portage fault.

§68. In a RR.* cut opposite N. H. Parker's house and 1 mile north of the McKean-Cameron line occurs a marked inconsistency in the rock dips which I can alone explain by the occurrence of a *slip fault.* The cutting is made in the Chemung. The strata consist of gray and brownish gray sandstones and shales containing a considerable amount of iron. The RR. at this point runs nearly north and south. At the 112th mile post the strata dip 20 degrees to the south; 400 feet south of the same point the dip is 8 degrees, while 50′ north of the mile post it is 60 degrees.

If more northern exposures could be obtained sufficient elements could no doubt be had to show the features of the fault. The topography in the vicinity indicates its existence and a careful delineation of the contour curves would probably determine the exact position and direction of the slip.



The accompanying illustration, shows the probable character of the fault, which is quite unique. I know of no other fault as great as the Sinnemahoning occurring in the comparative horizontal rocks of the bituminous coal region. The greater elevation of the Boon's mountain anticlinal at this point is probably the cause of the faulting.

* Near 112th mile post of the B., N. Y. and P. RR.

Norwich Coal Basin.

§ 69. The axis of this synclinal is that of the *Fourth bituminous basin.* In Potter it is known as the Coudersport synclinal while in Elk it is generally known as the St. Mary's, Toby creek or Dagus coal basin.

In McKean the extreme north-eastern coal outcrop is to be found on the high summit to the west of the axis, between the headwaters of Comes creek and Scaffold Lick run. The elevation of the bottom of the conglomerate at this point is about 2000 feet above tide. The elevation of the same stratum in the center of the basin immediately south of the Scaffold Lick run is 1925 feet. At the headwaters of Indian run about 8 miles to the south-west of the above the bottom of the conglomerate is 1955 feet. This would go to show that there is no progressive dip to the south-west in the center of the basin. In point of fact the basin itself is dimpled; the Potato creek basin being in one dimple while the coal area south of Norwich is in another dimple.

There are two thorough cuts at right angles to the axis. The north-eastern one is made by the Allegheny Portage creek which has eroded a valley down to the Catskill red shale, No. IX, and a more southernly one is made by Havens brook. A narrow neck of the OLEAN CONGLOMERATE under Havens brook summit connects the outcrop of the Pottsville conglomerate No. XII in the two dimples or sub-basins. The south-eastern dips on the western side of the axis are slightly greater than the north-western dips on the eastern side. This fact is shown, in a general way on the county geological map, by the axis of the basin being nearer the center of the fourth anticlinal than it is to the third.

Norwich Anticlinal (Fourth) Axis.

§ 70. This axis, known in Potter as the *Roulet—Hebron—Bingham anticlinal,* is first observed in Bingham township in that county, bordering on the New York State line. It forms a valley which has a direction south 55°

of two or more benches of coal, separated by slate, shale, or fireclay. The interval between the middle and lower or bottom coal of the series is made up of fireclay, sandstone, and slate. Sometimes the three kinds of strata alternate, but more frequently it is all fireclay. The lower coal is extremely sporadic; it generally consists of two or three thin coal layers, alternating either with fireclay or slate, the total thickness varying from one to three feet. No limestones have ever been found which could be taken as representatives of the Mercer limestones.

The upper coal bed has been worked in the old Buttsville mine (elevation 2063 feet). It is subject to more local variations and is more treacherous to mine, than the middle or *Alton coal*. The alternating layers of slate, shale and fire clay contained in this latter bed reduces the workable coal down to about 3 feet. It has been mined extensively, at Alton and Bond Vein; and has been opened and tested in several other localities. The lowest coal of the series has never been mined; but it has been proven in a number of shafts and drill holes. I do not regard it a commercial coal.

§ 242. The KINZUA CREEK SANDSTONE like the Johnson run sandstone has a variable character within the township; as the detail description of the drill holes shows. This sandstone was not found exposed in situ any where in the township. In fact the same may be said of the Johnson run and Olean rocks. They have all been drilled through and their horizons can readily be determined by the topographical features which they form. Large loose blocks, of all the sandstones, may be found and the lithology of the strata be studied as well as if they were found in bold outcrops. Immense fragments of the Kinzua creek sandstone may be found near the summits of the hills, along the Kinzua creek valley; and it is from this fact that the rock has been named. It seems to have a more massive character in the western part of the township, than it has in the eastern or southern portion.

§ 243. The *Upper Marshburg coal* occurs in the slate and sandstone interval between the *Kinzua creek* and *Olean* rocks. The thickness of the coal has not been accurately

Erie railroad 3½ miles south of Wilcox, passes under Mont Morency and crosses the Elk-Jefferson line 2 miles east of the south-western corner of Spring Creek township, Elk county.

The course of the axis in McKean is south 51° west. The most north-eastern coal outcrop in this basin is in the south-western corner of Liberty township in the *Skinner creek coal patch.* The elevation of the bottom of the OLEAN CONGLOMERATE at this point is 1950 feet. In the center of the basin at Clermont it is 1925 feet and at Williamsville 1850 feet. This shows that the dip in the direction of the axis is very slight.

The Fifth basin in McKean is a long symmetrical trough; more so than either the Fourth basin to the east or the Sixth basin to the west.

Smethport Anticlinal (Fifth) Axis.

§ 72. This is the extreme western of the recognized anticlinal axes in McKean county. It enters Potter from New York about the middle of the northern boundary line of Oswayo township, passes through the broad valley (5 miles) in Sharon township and enters McKean near the north-eastern corner of Annin township.

Its course is parallel to the axis of the Fifth synclinal as far as Smethport where the flexure seems to end abruptly in the *dome* by which the strata under Prospect hill have been elevated. It commences again west of the county seat. Its axis lies to the west of Marvin creek valley. It intersects the Kinzua-Emporium axis under the Seven Mile summit and enters Elk directly south of the Wilcox wells. The intersection of the two anticlinals produces a *dome* to the north of the Seven Mile summit which elevates the strata in the Howard Hill region.

The axis has nearly a straight course from where the West Clarion creek crosses the McKean-Elk line to Cooksburg on the Clarion river at the junction of Forest, Clarion and Jefferson counties.

South-west from Cooksburg the flexure is known as the Brady's Bend anticlinal, first named by Prof. Lesley.

Alton (Sixth Bituminous) Coal Basin.

§ 73. The *Sixth basin* has generally been considered to include all that portion of western Pennsylvania west of the Fifth or *Brady's Bend anticlinal.* During recent surveys it has been found to be broken up into a number of sub-basins by minor axes.

The principle axis west of the Fifth is what has been called the *Millerstown anticlinal.* It commences apparently just west of the junction of the four counties Elk, McKean, Warren and Forest; passes through the latter county about 3 miles (more or less) north-west of Marien and enters Clarion about 2 miles west of its north-eastern corner.

Its course through Clarion is nearly straight. It crosses the Allegheny river just below Monterey and passes to the east of Millerstown, Butler county.

The *Harrisville* and *Fredericktown* axes occur to the west of the Millerstown axis. No trace of the former has been found in Forest and the prolongation of the latter would pass considerably to the west of this county.*

In McKean the Sixth basin may be said to include all that portion of the county west of the Smethport axis.

No general axis in the basin was determined on account of the variable dips resulting from the Kinzua-Emporium axis.

Kinzua-Emporium Cross Anticlinal axis.

§ 74. The discovery of this anticlinal which crosses at right angles the Third, Fourth, Fifth and Sixth coal basins in Cameron, Elk and McKean counties is possibly the most important recent contribution to the structural geology of this portion of the State.

The first interpretation of the structure of the *bituminous*

* See reports QQ, V and VV.

coal region was, that the entire area of western Pennsylvania west of the Allegheny mountain crest was plicated by a series of flexures forming six long synclinal troughs separated by anticlinals or parallel zones of elevation. It was subsequently found that neither the basins or ridges formed in the otherwise horizontal strata were symmetrical throughout their entire length; but that they were broken up into sub-basins by the strata in some portions of the center of the basin being elevated while others were depressed. The result being that instead of the synclinals being long symmetrical troughs they consisted of a succession of *domes* and *dimples*.

In my general examination of the district it was found that such *domes* or areas of elevation existed both in the synclinals and on the anticlinals. The dips were so gentle that this feature in the structure was only obtained by accurately determining the elevation and dip of the bottom of the OLEAN CONGLOMERATE.

It was at first ascertained that north-east and south-west dips parallel to the principal axes existed at the following points:

In the *Kinzua valley* near the McKean-Warren line; in the north-western corner of Hamlin township; at Howard Hill, and at Williamsville; all in McKean.

On the headwaters of *West creek*, Jones township, Elk county, the red Catskill No. IX is elevated above water level and found outcropping along the banks of the creek.

At *Emporium*,* Cameron county, the Chemung rocks No. VIII are found covering a considerable area in the bottoms of the valleys over the Emporium *dome*. At the junction of Gibson, Lumber and Grove townships, also in the same county, north-east and south-west dips were found to exist in the OLEAN CONGLOMERATE. A similar structure was found to exist on the high summit east of the valley of the *East branch of Sinnemahoning creek*.

* This is the only locality in Cameron where Chemung rocks outcrop, while in Elk the erosion has not cut down to the Chemung formation; in fact if we exclude Benezette township, this county, there is but one outcrop of red Cats-

It was afterwards found that if a line be drawn through these points the strata throughout its entire length dipped away from the line toward the north-east and south-west.

The *age of this flexure* is a question of great interest, but is shrouded in uncertainty. There are many reasons for believing that the flexure commenced to be formed in *pre-Pocono time*, or prior to the deposition of the Pocono strata. It seems quite certain that it did occur before the great *Appalachian revolution* which plicated the rocks at the end of the Coal period. The position of the anticlinal has possibly changed very much from that which it occupied when the weakening of the earth's crust first commenced in this locality.*

* For a further discussion of this subject, see the description of Pocono rocks, page 70.

CHAPTER IV.

The stratified rocks of McKean County.

§ 75. The rocks which form the surface of McKean and which have been pierced in the oil wells belong exclusively to the Carboniferous and Devonian ages.

A general scheme of the Pennsylvania formations is given so that the reader may understand the relation existing between the formations described in this report with those reported on in the other published volumes of the survey.

The names of the formations are those which were originally proposed by the New York Geological survey, and which were adopted by the First survey of Pennsylvania. The geographical names above the *Catskill sandstone* have been given by Prof. Lesley to those rocks of the Pennsylvania section which are not found in the State of New York.

The formations found in McKean are:

Carboniferous System.

Lower Productive coal measures, ...	XIII
Pottsville conglomerate, ...	XII
Mauch Chunk red shale (?), ...	XI
Pocono sandstone, ...	X

Devonian System.

Catskill sandstone, ...	IX
Chemung sands and shales, ...	VIII

Of these the most important are:

1. The Lower productive coal measures which contain the *Dagus coal bed* and the *Clermont coal bed.*

2. The Pottsville conglomerate which contains the *Alton coal beds.*

3. Chemung sands and shales which contain the *productive oil sands* of the BRADFORD or NORTHERN OIL DISTRICT.

PALÆOZOIC TIME.

I. THE CARBONIFEROUS SYSTEM.

1. *Monongahela river coal series.*	
Upper barren measures.	
a. Green county group.	
b. Washington county group.	
Upper productive coal measures.	
2. *Allegheny river coal series.*	
Lower barren measures.	
Lower productive coal measures,	XIII.
Pottsville conglomerate (Seral, Millstone grit),	XII.
3. Mauch Chunk red shale, including the mountain limestone,	XI.
Pocono sandstone (Vespertine),	X.

II. THE DEVONIAN SYSTEM.

1. Catskill sandstone (Old Red,)	IX.
2. Chemung sands and shales,	
3. Portage shales and sands,	
4. Hamilton formation,	
Genesee black shales,	VIII.
Hamilton sandstone,	
Marcellus black shales,	
5. Upper Helderberg limestone,	
6. Oriskany sandstone,	VII.

III. THE SILURIAN SYSTEM.

1. Lower Helderberg limestone, water limestone,	
Salina shales,	VI.
Niagara shales and limestone,	
2. Clinton red and gray shales and fossil iron ores,	V.
3. Medina sandstones,	IV.
4. Oneida sandstone and conglomerate,	

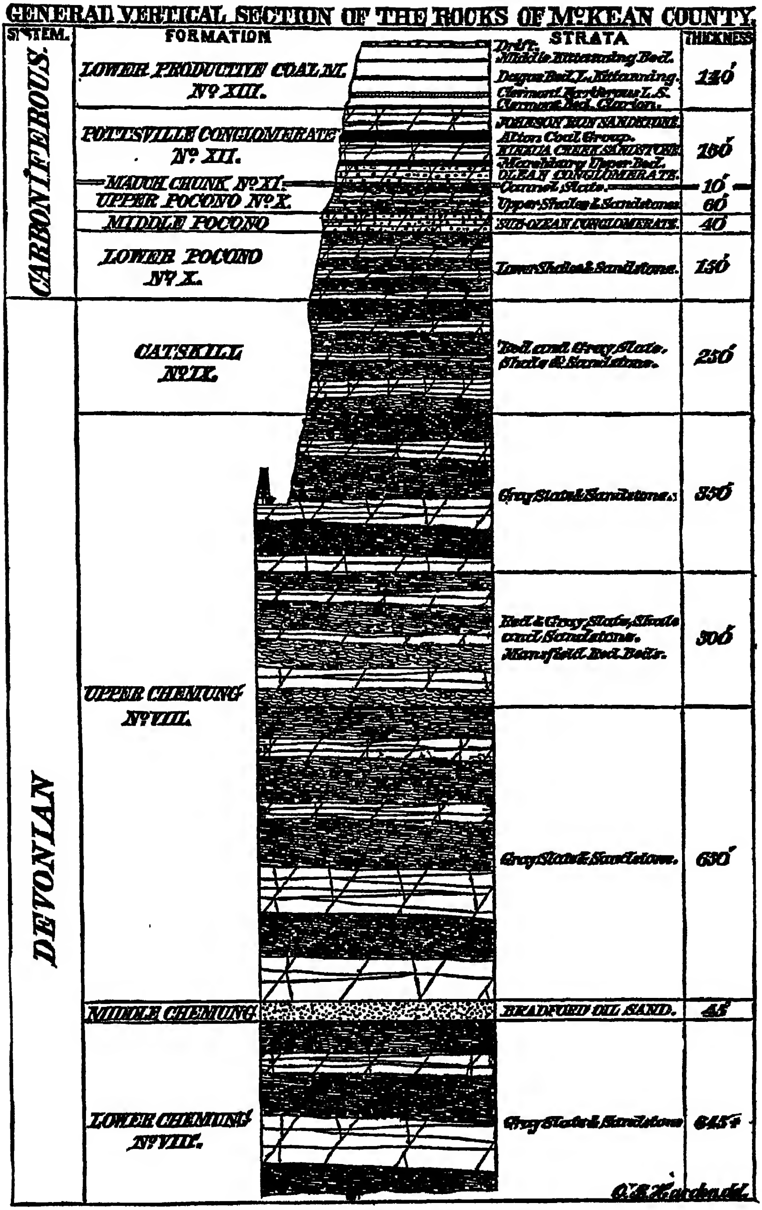
IV. THE SILURIAN CAMBRIAN SYSTEM.

1. Hudson river slates,	III.
2. Utica slates,	
3. Trenton limestone.	
4. Magnesian limestone, chazy, calciferous, &c.,	II.
5. Potsdam sandstone,	I.

V. THE CAMBRIAN SYSTEM.

VI. THE HURONIAN SYSTEM.

VII. THE LAURENTIAN SYSTEM.


GENERAL VERTICAL SECTION OF THE ROCKS OF McKEAN COUNTY.
SYSTEM.
FORMATION
STRATA
THICKNESS
CARBONIFEROUS.
LOWER PRODUCTIVE COAL M. No XIII.
Drift.
Middle Kittanning Bed.
Dagus Bed L. Kittanning.
Clermont Ferriferous L.S.
Clermont Bed. Clarion.
140'
POTTSVILLE CONGLOMERATE No XII.
JOHNSON RUN SANDSTONE.
Alton Coal Group.
KINZUA CREEK SANDSTONE.
Marshburg Upper Bed.
OLEAN CONGLOMERATE.
160'
MAUCH CHUNK No XI.
Cannel Slate.
10'
UPPER POCONO No X.
Upper Shales & Sandstones.
60'
MIDDLE POCONO
SUB-OLEAN CONGLOMERATE.
40'
LOWER POCONO No X.
Lower Shales & Sandstone.
150'
DEVONIAN
CATSKILL No IX.
Red and Gray Slate, Shale & Sandstone.
250'
Gray Slate & Sandstone.
350'
Red & Gray Slate, Shale and Sandstone. Mansfield Red Beds.
300'
UPPER CHEMUNG No VIII.
Gray Slate & Sandstone.
630'
MIDDLE CHEMUNG
BRADFORD OIL SAND.
45'
LOWER CHEMUNG No VIII.
Gray Slate & Sandstone
645'+

§ 76. The total thickness of these rocks which have been studied in the State would amount possibly to forty thousand feet (40,000′) or about eight (8) miles.*

The rocks which may be studied in McKean form but a *very small* proportion of those which have been described in other sections. Very few of the formations have representatives in the surface sections and oil well records and those which do occur have a minimum thickness.

The Pottsville conglomerate, which at Pottsville in Schuylkill county has a thickness of 1000 feet, in McKean is represented by the JOHNSON RUN SANDSTONE, *Alton coal group*, KINZUA CREEK SANDSTONE, *Marshburg upper coal rocks* and the OLEAN CONGLOMERATE, having an aggregate maximum thickness of 190 to 210 feet.

The Mauch Chunk red shale No. XI at Mauch Chunk in Carbon county is about 3000 feet thick, while in McKean at the most, it is 10 feet thick. So too with the Pocono and Catskill formations; their minimum thickness in the State is that in McKean. The Pocono rocks under the Broad Top mountain in Huntingdon county are 2133 feet thick, in McKean (at Bradford) only 247 feet.

In Blair county Mr. R. H. Sanders makes the Catskill rocks 2560 feet thick† at Bradford they are 250 feet.

The thickness of the Chemung is not known in McKean, so that no comparison can be made with other sections in the State.

General McKean Section.

§ 77. The accompanying section shows the thickness of the formations found in the county.

This section would represent the rock thicknesses to be obtained about the center of the county. The lowest rocks are those encountered in the Smethport wells.

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*In Huntingdon county I have measured 3½ miles of the Palæozoic rocks, extending from the top of the Lower Productive coal measures down to the base (?) of the Trenton limestone. When it is remembered that the rocks shown in this section are but a small proportion of the Palæozoic column, the estimate of 8 miles is certainly not excessive.

† Report F, page 263.

Chapter V.

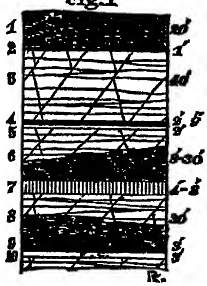
The Lower Productive Coal Measures.

§ 78. The rocks which represent this group in McKean have only a thickness of 140 feet* and contain but two *commercially productive* coal beds only one of which has ever been mined; the *Clermont coal bed.*

The general character of the strata forming this group is shown in the following generalized section:

1.	Gray and black slates,	20′
2.	*Coal,*	1′
3.	Gray and brown sandstone,	40′
4.	*Dagus coal,*	2′ 9″
5.	Fireclay,	2′
6.	Sandstone and slate,	8′ to 30′
7.	*Clermont (Ferriferous) limestone,*	4′ to 8′
8.	Sandstone and slate,	30′
9.	*Clermont coal,*	3′
10.	Fireclay,	3′
	Johnson run sandstone, top member conglomerate series,	—
		140′

Fig. 1



§ 79. Three coal beds are shown; the highest, which is 1 foot thick, is no doubt the representative of the *Kittanning middle coal.* Clermont is the only locality where this coal bed has been found. Here its area is very limited and it is not of workable size.

§ 80. Forty feet under the *Kittanning middle coal* occurs the *Dagus coal* or the *Kittanning lower bed.* About 40 to

* It must be remembered by the reader, that what are known as the Lower Productive coal measures, in the grouping of the *Allegheny river coal series,* do not include all the productive coals of McKean county. The Alton coal group which contains the better known workable coal beds of the county occurs in the Pottsville conglomerate series, No. XII. The reasons which have induced me to place the Johnson run sandstone and *Alton coal group* in the conglomerate series are detailed in the description of these rocks.

50 acres in the Clermont or Fifth basin are found underlaid by this bed. It ranges from 2½ to 3 feet thick. In the Norwich or Fourth basin the same bed has been opened at what is known as the Coal-pit opening.

In the Alton or Sixth basin the hills are not sufficiently high to include this bed.

At Howard Hill the *Kittanning lower bed* is represented by coal No. 12 of Mr. Dalson's section (see page 172). At Clermont the *Dagus coal* occurs only 12 feet above the *Clermont (Ferriferous) limestone.* The thickness of the included rocks at this point is exceptionally small. It generally ranges from 35 to 40 feet.

§ 81. The bottom coal of the Productive series as they are placed in the general scheme is the *Clermont bed.* It is found from 60 to 70 feet under the *Dagus bed* and is separated from it by an interval of sandstone and slate. The coal is the representative of the *Clarion coal.*

Comparison of results.

§ 82. The following grouping of the Lower productive coal measures is that which has been generally adopted for western Pennsylvania:

Mahoning sandstone base of Lower Barren coal measures.
Upper Freeport coal, bed E.
Upper Freeport limestone.
Lower Freeport coal, bed D.
Lower Freeport limestone.
Upper Kittanning coal, bed C″.
Johnstown cement bed.
Middle Kittanning coal, bed C′.
Lower Kittanning coal, bed C.
Ferriferous limestone.
Clarion coal, bed B.
Clarion sandstone.
Brookville coal, bed A.
Pottsville conglomerate, No. XII.

The *Clermont limestone* has been carefully traced to the south and southwest, and I have determined its horizon in

the sections of the coal measures in McKean, Cameron, Elk, and Forest counties, and have identified it with the *Ferriferous limestone*, in northern Jefferson, Clarion, and Venango. This gives us an absolute basis for comparison.

According to the general scheme above, the first coal bed below the *Ferriferous limestone* (30 to 40′) is the *Clarion bed*, and below the *Clarion*, the *Brookville*. On the basis of this comparison the following would result:

Clermont limestone	=Ferriferous limestone.
Clermont coal	=Clarion coal.
Johnson run S. S.	=Clarion S. S.
Alton coal group	=Brookville coal.
Kinzua creek S. S.,	
Marshburg Upper coal,	=Pottsville conglomerate, XII.
Olean conglomerate.	

These conclusions would satisfy those arrived at by Mr. W. G. Platt in tracing the coal measures from the crest of the Allegheny mountain, above Altoona, westward through Cambria, Indiana, and Armstrong counties to the Allegheny river.

In comparing my sections with those constructed by Mr. John F. Carll, in Venango; by Mr. H. Martyn Chance, in Clarion and northern Butler; and by Prof. White, in Mercer and Lawrence, the following world result:

Clermont limestone	=Ferriferous limestone
Clermont coal	=Clarion coal.
Absent.	Clarion S. S.
"	Brookville coal.
Johnson run S. S.	=Homewood S. S.
Alton coal group	=Mercer coal group.
Kinzua creek S. S.	=Connoquenessing S. S's
Marshburg Upper coal	=Sharon coal.
Olean conglomerate	=Sharon conglomerate.
Marshburg lower coal	Absent.
Pocono Upper shales and S.S's	=Shenango shales.
Sub-Olean conglomerate	=Shenango S. S.

Messrs. Carll, Chance, and White are all agreed that the Homewood sandstone marks the top of the Pottsville conglomerate. Messrs. Carll and Chance have tracėd this sandstone into Forest county and proved it to be the top rock (Tionesta sandstone) at Marien. I have traced the Johnson run sandstone through McKean and Elk county, and proved it to be represented by the same top rock at Marien, so that it is placed beyond a doubt, that the Homewood sandstone is the southwestern extension of the Johnson run.

In McKean the Alton coal group lies directly underneath the Johnson run rock; in Mercer county the Mercer coals occupy the same relative position to the Homewood sandstone; so that there is little question but that the Alton and Mercer coal beds are found in the same geological horizon. But mark, if the Alton coals are really the Brookville bed, very much expanded and broken up into several beds, then the Mercer coals must also be represented by the Brookville bed. All the district geologists, who have worked in the Bituminous coal region, concede the fact that the Brookville coal is very much superior to the Mercer coals.

Again Mr. Chance in his report (VV) on Clarion county shows that the Homewood sandstone rises and cuts out the Brookville coal bed and that the coal which lies on top of this sandstone in northern Clarion and southern Forest is the representative of the Clarion bed; so that Mr. Chance forces upon me the conclusion, that nowhere within the four counties which I have examined have I found a true representative of either the Brookville coal or Clarion sandstone.

Everything tends to show that this latter comparison, which I have suggested is the correct one. Which ever one shall be finally shown to be correct it will not affect the local geology of the district. While I believe that the Pottsville conglomerate in McKean is represented by the, Johnson run sandstone, Alton coal group, Kinzua creek sandstone, Marshburg upper coal and the Olean congomerate I have preferred to consider the question an open one and use for these several formations purely local geographical names.

Chapter VI.

The Pottsville (Seral; Millstone Grit) Conglomerate Measures.

§ 83. One of the most important problems which has concerned the present survey of the northwestern part of the State is the *correct definition* of the coal measure or Pottsville conglomerate, No. XII corresponding to the *Millstone grit* of Prof. Dana's section and *Seral* of Prof. Rogers' final report.

It is not the purpose of a county report to give a general survey of the facts gathered from the entire district but to place local facts in an intelligible form so that final comparisons may be made.

In report RR on Cameron, Elk and Forest counties a general description will be given of the formation thoughout the four counties with a comparison of the sections obtained in the adjoining districts. In this report such conclusions have been adopted which seem to be supported by the greatest number of facts at hand. Any change which may have to be introduced in the future will merely change the comparison of names here indicated, it cannot alter the connection of the sections within the four counties comprising the district which I have examined.

In the Anthracite coal basin, where the conglomerate has received the name of Pottsville, it ranges in thickness from 1030 feet at Pottsville to 200 feet at Wilkesbarre. It consists of a mass of alternating massive sandstone and conglomerates, containing local coal slates and coal beds. In the isolated coal basin of the Broad Top mountain, the conglomerate consists of three distinct series of strata. An upper sandstone and conglomerate member, 160 feet. A middle member, composed of sandstones, shales, and coal

slates, containing a *coal bed* 40 feet. A lower sandstone and conglomerate member, 80 feet. In West Virginia southwest of Broad Top mountain, the conglomerate thickens rapidly; consisting of bottom and top massive conglomerates interlocking nine distinct coal beds with their associate slates and shales.

According to Mr. S. Fisher Morris, "from the top of the red shale of XI at Quinnimont, on the New river, West Virginia, to the top of the conglomerate, is about 1450 feet."*

Along the face of the Allegheny mountain west of Altoona, the conglomerate has a thickness a little over 200 feet. It consists of sandstones and conglomerates, with alternating shales, but rarely any coal beds of workable size.

As we recede westward from the face of the Allegheny mountains the conglomerate retains very much its general character and form, but the relative thicknesses of the alternating strata change very materially. The conglomerate beds become less pebbly (*locally*); the alternations of sandstone and shale become more frequent, and the interlocked coal beds increase in number, size, and purity. These changes, which are very gradual, coupled with the fact that the strata lie so nearly horizontal and are so generally covered with drift and local detritus, preclude the occurrence of bold and frequent outcrops by which the group may be traced.†

Johnson Run Sandstone.

§ 84. This sandstone is the top member of the conglomerate series. It consists of a rather massive, fine-grained, ferruginous sandstone, containing frequent alternations of slate and shale. The boldest outcrop of the rock is to be found in the *Johnson run coal basin* (Fifth Basin), east of

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* See paper on "The New River Coal-field of West Virginia," read before the American Institute of Mining Engineers, at the Montreal meeting, September, 1879.

† This applies more particularly to the northern tier of counties where most of my examinations have been made.

THE OLEAN CONGLOMERATE AT THE ROCK CITY,
CATTARAUGUS CO. N.Y.

Wilcox, Elk county. The sandstone has been named from this fact.* Its thickness ranges from 30 to 75 feet. The interval of the JOHNSON RUN SANDSTONE is the most variable in thickness and character of any forming the coal measures within the district.

Alton coal group.

§ 85. This group of coal beds is the most extensive and probably the most important in the county. With the exception of *very small areas* of the *Clermont* and *Dagus beds*, it includes all the coals which are of commercial value.†

The group is composed principally of shale, slate and fire-clay and usually contains three distinct and well marked beds of coal:

The *Alton upper bed*,
Alton middle bed (*Alton coal*),
Alton lower bed.

Rarely more than one bed is sufficiently thick in any one locality to be workable. In fact nowhere in the county have any two beds been worked, one above the other.

The thickness of the group varies. In the Alton basin, Lafayette township, it is from 30 to 35 feet. At Clermont, and east of Norwich, it is about 20 feet thick.

The *upper coal* has been worked in the old mine at Buttsville and is now being worked by the Buffalo Coal Company in their new mine near Clermont. It generally consists of one solid bench.

In the Potato creek basin, east of Norwich, the bed has been proven at the Blue, Spring and Rochester cannel openings. In thickness it ranges from 2 to 3½ feet. This coal is the representative of the *Tionesta bed* of Rogers' final report and of report QQ (page 55). It would seem

* A more detailed description of the conglomerate series, may be found in the township reports.

† The market value of the Alton group coals is very small when compared to the higher and purer beds of Elk and Jefferson. They are high in ash and sulphur; are difficult to mine; their character and thickness are subject to sudden changes; so that they can only be profitably worked when sufficiently near to the consumer to have the advantage of low railroad rates.

more natural to include this coal in the Mercer group instead of calling it Tionesta, just as I have included it in the Alton group.

§ 86. The *Middle coal* or *Alton bed* proper is generally separated from the top coal by 5 to 12 feet of fireclay, slate or shale. Unlike the upper coal it is invariably made up of 2 to 4 distinct benches of coal which are parted from one another by slate or fireclay. The only place where this bed has been mined is in Lafayette, and more particularly in the vicinity of Alton, hence the name of Alton bed. Its range of thickness is from 4 to 8 feet, including the separating strata. This bed seems to be absent in the Clermont basin. In the Norwich (Potato creek) basin it is represented by the rider of the Hamlin bed.

§ 87. The *lower coal* lies at the bottom of the group and immediately on top of the KINZUA CREEK SANDSTONE, from which it is separated by its under clay. The bed has its maximum development in the eastern part of the county and seems to rapidly deteriorate both in thickness and quality to the west. In the Norwich basin it has been opened at the Hamlin, Splint and Lyman camp openings. The average section of the coal at these openings may be stated as 4 feet. At Clermont the bed has been proven directly opposite the railroad station near the mouth of the mine No. 1. In the *Alton basin* the coal is represented by very thin and sporadic coal beds. In this latter basin this bed has never proved of workable size.

§ 88. No *limestone* or calcareous beds have ever been found in the Alton group in McKean, Cameron, Elk or Forest, so that, although the group resembles in most of its features the Mercer group of Lawrence and Mercer, it differs essentially from it in containing no limestones to represent the Mercer limestones described in report QQ.

§ 89. The shales separating the coal beds frequently contain scattered nodules of iron carbonate ore. The ore does not seem to be regularly stratified and it has never been found of sufficient quality and quantity to prove workable. It would represent the Mercer iron shales along the Pennsylvania Ohio line.

THE OLEAN CONGLOMERATE AT THE ROCK CITY, CATTARAUGUS CO. N.Y.

Irregularities in the Coal Beds.

§ 90. Many difficulties have been encountered in mining the Alton coal beds in the Alton basin which are quite characteristic and common to the group throughout the entire county.

The principal of them are:

1. Local dips forming swallows or sumps.*

Sometimes the sumps are formed by the lower portion of the bed having a greater dip than the upper portion; this means a thickening of the coal. Where these local depressions are small they may be drained by hand pumps; but it is seldom that their areas are sufficiently limited to permit of this rather primitive method.

2. Thinning of the coal bed away into a knife's edge.

In this case the coal, and frequently its under clay, thins away on a sandstone bottom which has a dip greater than that of the coal. The width of these sandstone hillocks† which cut out the coal varies from a few feet up to several hundred. This feature is of more usual occurrence in coals of the Alton group than in the Clermont. After the coal bed has thinned out to a few inches or has entirely disappeared in the mine, if the drift be continued through the obstructing sandstone it will eventually come into the coal bed again.

3. Fireclay and slate which generally separate the several benches of a coal bed are frequently replaced by sandstones. This renders the miner's work much more difficult. The change of rock structure is found to exist more particularly in the sumps.

When this irregularity occurs in the *Clermont bed*, which

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*The name swallow seems to be purely local. Sump does not properly represent low portions of a coal bed forming a closed basin, but is that portion of a shaft or pit which extends down below the bed and which forms a receptacle to hold the water of the mine, from which it may be pumped. A very suggestive distinction is that of a natural sump to designate the former and an artificial sump to mean the latter.

†The miners generally call these sandstone hillocks "horse-backs" or simply "horses." The name horse is a rather indefinite term and is usually applied to any rock-matter which lies in the way of the miner.

is invariably one solid bench, it is represented by the local presence of slate and fireclay partings in portions of the seam which do not ordinarily contain any foreign strata. The upper part of the seams are more subject to this variation than the lower.

4. Stream erosion, by which the coal has been cut out by streams flowing over the peat bog or fallen vegetation prior to the sedimentation of the mud and sand forming the roofing rock. The stream bed has subsequently been filled in by material which has formed a fireclay or rotten shale, sometimes a sandstone* in the upper part of the coal bed.

The fireclay is generally very hard. Evidences of this action were seen especially in the *middle coal bed* of the Alton group which is mined at Bond Vein.

5. The coal seam is frequently replaced by a very hard fireclay which is flat on top against the roofing slate and has a lower spheroidal surface, sometimes quite spherical, at other times canoe shaped.

These are in reality pot holes which have been filled in with fine mud. The holes are similar to those which are often now seen in the harder rocks.†

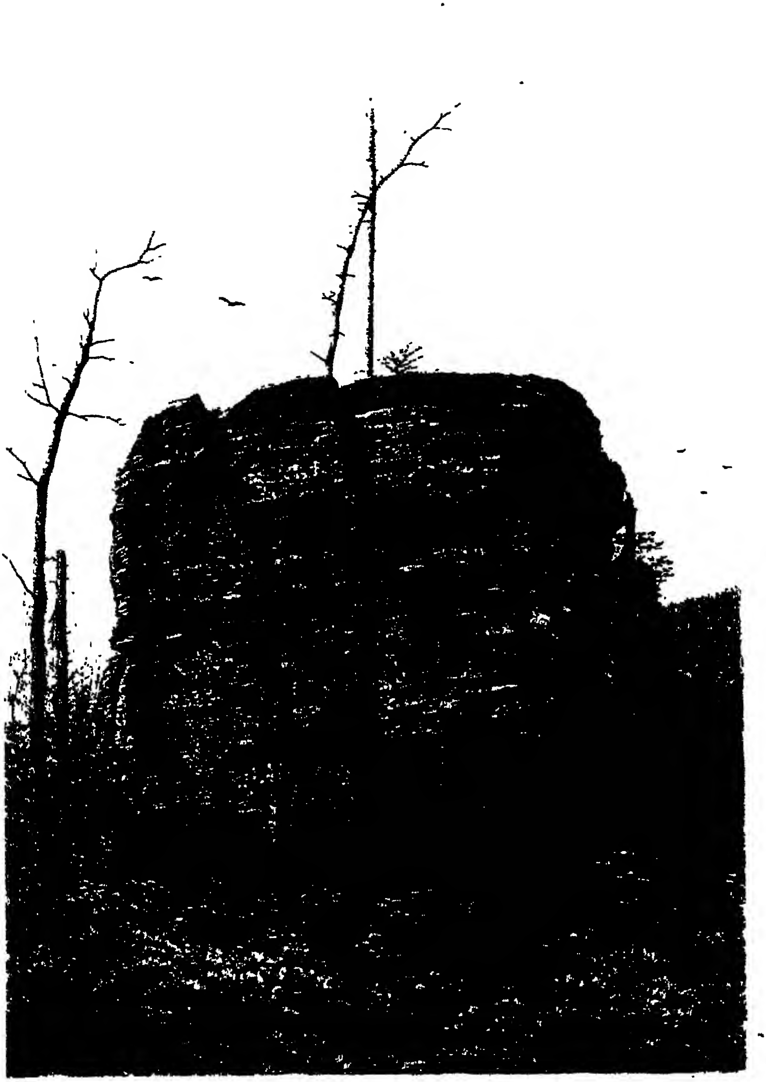
Kinzua Creek Sandstone.

§ 91. The middle sandstone member of the Pottsville conglomerate occupies the interval between the Alton group and the *Marshburg upper coal* and coal slates. It represents the Upper and Lower Connoquenessing sandstones with the included Quakertown coal and iron shales described in reports QQ, QQQ, &c.

The character of the rock, in its general aspect, is very similar to the JOHNSON RUN SANDSTONE, and in many localities bears a close resemblance to the OLEAN CONGLOMERATE. It is less massive and ferruginous than the former and has a

* In many places in England where this stream erosion in the coal beds has taken place it is known as *nips-out* or *dead ground.*

† In the vicinity of North Conway, N. H., I have seen such holes 5 or 6 feet deep worn into the solid granite in the beds of streams.



THE OLEAN CONGLOMERATE AT THE ROCK CITY, CATTARAUGUS CO. N.Y.

less conglomeritic and homogeneous structure than the latter. It breaks up and crumbles more rapidly upon exposure to the weather than either the upper or lower sandstone members of the conglomerate series. This fact precludes the existence of bold outcrops; the surface of the rock being invariably hid by debris from the Johnson run or Alton group strata. I do not recall a single exposure of the rock *in situ* in the county, where a face of sandstone 15 feet high may be seen. Huge blocks may be found on most of the hill-slopes, the summits of which are capped by strata superior to the sandstone. This fact is especially noticeable in the Kinzua creek valley, from whence the rock takes its name.*

In this valley the sandstone has a character which it is found to maintain, with but little change, generally throughout the district. The quartz grains are frequently whiter, more angular and are surrounded with less cementing material than either the Johnson or Olean rocks. It differs from the Johnson run in containing a few pebbles and from the Olean in containing very much smaller and fewer pebbles.

The thickness of the sandstone varies but little in the county; it is generally found between the extreme limits of 45 and 60 feet.

The sandstone strata frequently alternate with shale and slate beds and often times a sporadic coal bed is found below the center of the rock. The sections of the sandstone obtained are not sufficiently detail to suggest a final comparison but it seems quite probable that this coal is the representative of the *Quakertown bed* lying between the two CONNOQUENESSING SANDSTONES.

Marshburg Upper Coal (Sharon).

§ 92. This *coal* which is sporadic in its occurrence; is found in a shale and slate interval, from 5 to 15 feet thick between the KINZUA CREEK SANDSTONE and OLEAN CONGLOMERATE.

*At first the rock was simply called Kinzua sandstone, but after it was found that the Rock City near Kinzua village was formed for the most part of the Olean conglomerate I decided to substitute the name Kinzua creek for Kinzua.

The average distance of the bed below the top of the conglomerate, No. XII, is 125 feet, or about 170 feet below the top of the *Clermont* (*Ferriferous*) *limestone.* At Keel Ridge, Hickory, Mercer county the coal is 225 feet below the top of XII. In Lawrence it lies from 250 to 300 feet below the top of the *Ferriferous limestone.* This would show a thickening of these strata between McKean and Lawrence of from 125 to 175 feet. A portion of this excess of thickness would be absorbed by the *Brookville coal* and shales between this bed and the *Clarion coal* coming into the section to the south-west; but the bulk of it would be accounted for by a thickening of the conglomerate series.

In the vicinity of Marien, Forest county No. XII is about 125 feet thicker than it is in Lafayette. A series of sections to accompany report RR will show the details of the expansion of the conglomerate to the south-west.

The *Marshburg upper coal* bed has been opened in a number of places in the Alton and Clermont basins, but it has never been worked to any extent. In fact the bed is too thin and the coal is too poor to be profitably mined. It has many of the features which characterize its representative (*Sharon bed*) in Mercer.

Olean Conglomerate.

§ 93. The base of the Pottsville conglomerate is formed by the stratum which has its typical outcrop at the Olean Rock City, 6 miles south of Olean, Cattaraugus county, New York. This rock is the most important one in the district and serves as the best guide to a correct comparison of the coal and oil well sections.

It has played an important part in the local geology of the county and has generally been taken to be the sole representative of the *coal measure conglomerate* (Seral of Rogers). On account of the great difficulty of distinguishing it from the SUB-OLEAN CONGLOMERATE and the two upper sandstone members of XII, the sections of the coal measures in the local reports have been thrown into the greatest possible confusion.

The OLEAN ROCK generally consists of a loosely cemented

The OLEAN CONGLOMERATE.

white or gray conglomerate containing prolate spheroidal pebbles ranging in size from a pea to a goose egg; or of a loosely cemented coarse grained sandstone. The grains of quartzite forming the body of the sandstone or conglomerate are not as sharp or angular as those forming the KINZUA CREEK SANDSTONE. This forms one means of distinguishing the two.

§ 94. The conglomerate beds are very variable both in their extent and thickness, while the entire thickness of the rock *en masse* remains remarkably uniform. In other words, the pebble beds are really local and lenticular in form. This is more noticeable in the northern part of the county.

§ 95. The sandstones lying between the conglomerate layers are frequently false or current bedded, (see Plate III.) Both of these facts indicate shallow water and shifting currents at the time of deposition; such as are at present found along our sea coast.

§ 96. The character of this conglomerate and the strata forming the Alton coal group seems to point to the conclusion that McKean county must have been near the edge of the Carboniferous sea and that the coal measures never extended very far north of the Pennsylvania-New York line.

§ 97. The extent and value of the coal areas are dependent upon a correct determination of the strata forming the Pottsville series and the SUB-OLEAN CONGLOMERATE (Middle Pocono, No. X). The following is a general review of some of the essential differences of these formations.

At the bottom we find a hard, massive, coarse-grained sandstone and conglomerate immediately overlying the green, gray and olive sandstones and shales which characterize the interval between the Olean and Sub-Olean conglomerates.

The pebbles in the upper conglomerate are invariably round or prolate spheroids (egg shaped) consequently this rock cannot be mistaken for the lower or SUB-OLEAN CONGLOMERATE in which the pebbles are flat or oblate spheroids having the shape of a flattened orange. The latter rock,

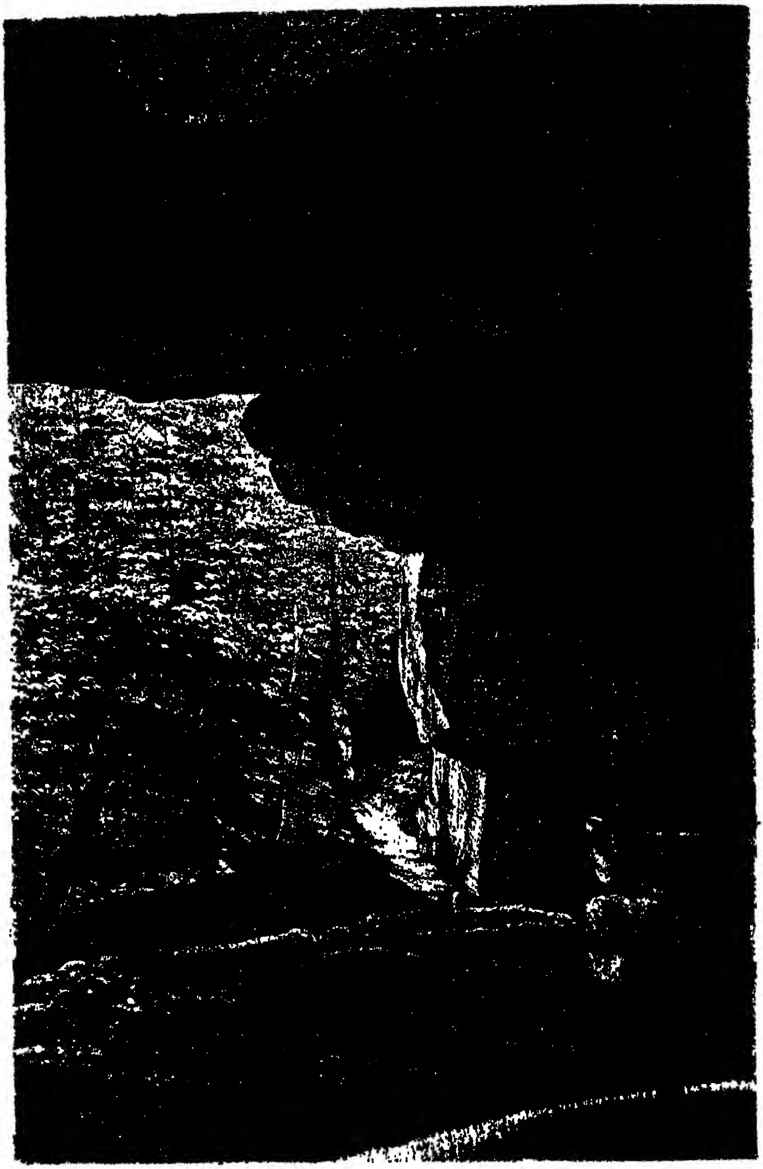
too, is quite different in lithological structure. It has a tendency to break into flags, is very ferruginous and contains iron and clay balls. No coal bed has ever been found associated with the Sub-Olean conglomerate.

Again, the bottom conglomerate and sandstone of our section is always overlaid by a mass of shaly sandstones and shales 10 to 15 feet thick containing locally a poor slaty coal which was first opened near Marshburg.

This conglomerate and sandstone cannot be the Kinzua creek sandstone for this latter rock although resembling very much the Olean strata is overlaid by a series of coal beds and underlaid by a single but irregular coal bed. Again the OLEAN CONGLOMERATE has not been mistaken for the Johnson run sandstone for this latter sandstone is underlaid by a series of coal beds and is capped by a very constant one bench coal bed (Clermont) which always lies at the base of 25 to 35 feet of alternating shales, sandstones and slates. This interval between the Clermont coal and limestone is the most constant of any in the coal measures in the northern counties.

The fact that the series contains no limestone and shows four distinct sandstones and conglomerates; JOHNSON RUN SANDSTONE, KINZUA CREEK SANDSTONE, OLEAN CONGLOMERATE and SUB-OLEAN CONGLOMERATE, occurring one above the other, without any very great separating intervals, has been the cause of numerous errors. The distance from the bottom of the lower member of this group of sand rocks, to the top of the upper member is 265 feet; and yet all of the four individual members have been mistaken for each other. The result can readily be imagined; for instance where the SUB-OLEAN has been mistaken for the JOHNSON RUN rock, the section of the coal measures would be exaggerated some 200 feet and *vice versa*. Unfortunately for the interests of the county the error has generally been one of exaggeration. When the distinguishing features of each rock become familiar to the experienced eye of the geologist or explorer but little difficulty is encountered in tracing the individual strata from place to place.

I believe I have definitely and finally settled the horizon



DINING HALL PASS, OLEAN, ROCK CITY.

PROFANITY PASS, OLEAN, ROCK CITY.

of the OLEAN CONGLOMERATE throughout western Potter, McKean, Cameron, Elk and Forest.

The absolute determination of one stratum in this series of sand rocks fixes the position of the associated strata.

§ 98. The rock has taken its name from its bold outcrop at the Olean Rock City. Here the base of the rock is 2340 feet above tide and it is broken up into huge cubical blocks having vertical faces from 30 to 40 feet high.

The character of the rock is shown in the accompanying plates I, II, III, IV, V and VI taken at the Rock City.

It is a popular belief that these rocks have been broken up and fractured through some earthquake movement. There is possibly no region of Pennsylvania which has been affected, directly, less by earth-crust movement than this northwestern portion. The evenness and regularity of the wide spread sheet of the Bradford oil sand bears testimony to this fact.

§ 99. The form in which the conglomerate is found at this locality is purely the result of the same eroding agents which have carved out all of the valleys. The eroding agents of McKean may be classed almost entirely under the head of physical, as the rocks are not such as would be directly affected by the chemical.

The physical agents may be classed as:

Aqueous,
Aerial and
Vegetable.

Flowing water with sand or sediment held in suspension is one of the most powerful sources of erosion; this has no doubt been the principal agent in cutting out the valleys. Analogous to this is the action of moving ice, though much more limited in its operation.

The agent which interests us most in accounting for the peculiar form of these *rock cities* is the expansion incident upon the freezing of water which has entered fissures or seams in the rocks.

These fissures and seams have first been formed in the sandstone and conglomerate by the contraction of the rock mass. The tendency being for the seams to form in verti-

cal planes. They have then been filled with water which has frozen and the consequent expansion has started a *straight* and *forward* movement. This movement is borne evidence to by the fact that the fissures which separate the blocks of stone are generally of the same width throughout. They vary from a few inches to 4 or 5 feet.

One of the necessary conditions for the formation of these rock cities is that the sandstone should be underlaid by a shale or slate bed which weathers less rapidly than the sandstone. This forms a level bed upon which the blocks may slide under the pushing force of the *freezing water*. In case the sandstone is not underlaid by such a stratum the rock will be broken up into blocks which will be shoved out of their position by the same force; but instead of retaining their level they will be pushed off the summit and rolled down the hill slopes. This latter is the most usual occurrence.

By the force of wind, especially when charged with sand, particles of the conglomerate have been loosened and permitted to drop out of their place when too large to be carried away. A very small amount of deterioration is accomplished in this way, yet it is easily distinguished on the face and surface of the blocks.

The growth of roots in minute crevices of a sandstone will oftentimes wedge off from the main rock a block of considerable size. The great expansive power of growing roots is well known and it is hardly less destructive in a sandstone and conglomerate than the stone dresses wedge.

§ 100. The following are barometrically determined elevations of the bottom of the OLEAN CONGLOMERATE at prominent points in the county. They are arranged not according to their geographical position but in the order of their relative topographical heights.

Prospect hill, Keating township,			2480′
Flat Iron rock,	Cattaraugus county,		2350′
Olean Rock city,	" "		2340′
Chapel hill Sergeant		twp.,	2300′
N. W. of Keating station, Norwich,		"	2275′
Bradford (Dennis well), Bradford		"	2170′
Marilla Summit,	"	"	2150′

DeGolier,	"	"	. . . . 2145'
Norwich hill,	Norwich	"	. . . . 2180'
Havens brook summit,	"	"	. . . . 2125'
Headbrook, Howard hill, Hamlin		"	. . . . 2040'
Smethport, Keating		"	. . . . 2025'
Bunker hill,	Sergeant	"	. . . . 2000'
Seven mile summit	"	"	. . . . 2000'
Big Shanty, Lafayette		"	. . . . 1990'
Marshburg,	"	"	. . . . 1975'
Ormby's summit, Keating		"	 1975
Huling's well No. 1. Hamlin		"	. . . . 1975'
Indian run, Norwich		"	. . . . 1955'
Skinner creek coal basin, Liberty		"	. . . . 1950'
Lafayette, Lafayette		"	. . . . 1945'
Clermont, Sergeant		"	. . . . 1925'
Buttsville, Lafayette		"	. . . . 1924'
Bond Vein,	"	"	. . . . 1912'
Wilcox wells, Sergeant		"	. . . . 1900'
Wetmore, Hamilton		"	. . . . 1880' (?)
Kane, Wetmore		"	. . . . . . 1870' (?)
Alton, Lafayette		"	. . . . 1878'
Williamsville, Sergeant		"	. . . . 1850'
Coburn Dry Hole, Wetmore		"	. . . . 1830'
Hukill Dry Hole,	"	"	. . . . 1798'
Ludlow, Hamilton		"	. . . . 1800'

General dips may be estimated from these elevations.

The approximate elevation of the Bradford oil sand may be determined by deducting from these heights the computed depth of the top of the sand below the bottom of the conglomerate (see plate, XI).

§ 101. The identification of the OLEAN CONGLOMERATE with the SHARON CONGLOMERATE seems to be finally settled.

I have traced the conglomerate through McKean to the west and make it equivalent to the seventy-seven (77') foot rock in the *Big Bend section* on the Allegheny river below Kinzua village, Warren county.

Mr. Carll has traced the SHARON CONGLOMERATE to the north-east and made it equivalent to the same seventy-seven foot rock. Tracing the conglomerate to the south-west into Forest it is found to be represented in Towler and Hunt well, No. 3, at Marien by,

Stratum No. 5, sandstone, pebbly, ...	= 98 feet
" " 6, blue slate, ...	= 25 "
" " 7, sandstone, ...	= 70 "
Total, ...	=193 "

Here the conglomerate is very much expanded. At Kane it is about 60 feet thick, in the distance of 22 miles between Kane and Marien the rock has expanded over 130 feet (193′—60′=133′).

Mr. Chance has traced the representative of the Sharon conglomerate through Butler and Clarion counties and made it equivalent to the same series of strata at Marien.

At Sharon, Mercer county, where the conglomerate has received its name, it is but 20 feet thick.

Prof. White has shown the equivalency of the *Ohio* COAL MEASURE *conglomerate* to the Sharon; so that the OLEAN CONGLOMERATE becomes the representative of the conglomerate of the Ohio geologists.

CHAPTER VII.

Sub-Conglomerate Measures.

§ 102. Mauch Chunk, No. XI; § 106. Pocono, No. X; § 112. Catskill, No. IX; § 114. Chemung and Bradford Oil Sand.

Mauch Chunk, No. XI.

§ 102. The place of the red shale of No. XI is immediately under the OLEAN CONGLOMERATE. No red shale is found in this position in the county, except in the southeastern part of Norwich township.

At the Wilcox wells, one mile north of the Elk-McKean line no exposures or red soil were found under the OLEAN; but 8¼ miles due south, at the Bear creek well, the drill went through the lower 25 feet of the OLEAN CONGLOMERATE and immediately below pierced

Red rock,	15′
Blue slate,	10′
Red rock,	20′
Total, No. XI,	45′

At the Silver creek well, about one mile from the Bear creek well, the same red shale bed was found directly underneath the Olean, both rocks being drilled through (see plate No. XI).

In the vicinity of Ridgway, Elk county, red shale and red soil are found occupying the same relative position to the conglomerate.

Both the conglomerate and red shale interval (50′) have been traced to the south-east through Cameron, and the sections have been connected with those constructed in Clinton county, where the horizons of both Nos. XI and XII have been clearly defined.

At Marien, Forest county, some thin red shale beds were found in the 70 foot slate interval, below the lower 70 foot sandstone member representing the bottom of the OLEAN.

§ 103. Generally throughout central and northern McKean the Mauch Chunk formation is represented by 5 to 10 feet of ferruginous argillaceous shale or black slate sometimes containing cannelly layers or a thin slaty coal (*Marshburg lower coal*).

At Clermont is found black slate which is very cannelly.

On the Boyer farm the slate has been opened as it was thought to represent a *coal bed* which by some of the local authorities had been given the name of MAMMOUTH BED. Judging from the money which has been expended in opening the *slate* it might rather be called a MAMMOUTH FRAUD.

§ 104. In the vicinity of Marshburg a poor slaty coal bed was opened directly under the conglomerate. For this reason I have called the bed the *Marshburg lower coal.*

At Ridgway this same coal has been found on the Gresh hill north of the RR. station.

§ 105. Prof. White, in report QQQ, page 48, says "the *Mountain limestone* (Umbral, Mauch Chunk, No. XI,) or *Maxville limestone* of Southern Ohio should be found" below the *Quakertown under-shales and ore* and above the Connoquenessing lower sandstone. According to the comparison of rock sections which I have provisionally adopted, and accepting Prof. White's location of the *Maxville limestone* in the Mercer county section, its geologic position in McKean would be in the lower part of the Kinzua creek sandstone which represents the Connoquenessing sandstones.

No limestone has ever been found in the district to represent the wide-spread bed known as the *Mountain or Sub-Carboniferous limestone.*

Pocono (Vespertine) No. X.

§ 106. This lowest formation in the *Carboniferous age*, is one of the most interesting in the district to the geological student. Fewer exposures are found in it than in any of

the rock groups composing the McKean section, for this reason it becomes the most difficult to describe with that minuteness which is necessary to a proper understanding of its structure.

The strata composing the group are subject to marked changes both in character and thickness.

Throughout northern and western McKean and northwestern Elk, near the top of the series is found one of the boldest and most important conglomerates of northwestern Pennsylvania, the SUB-OLEAN. In the southeastern part of the county this rock fines down and has no representative which can be distinguished.

At Bradford the Pocono is 250 feet thick, while in a distance of 37 miles to the south (at Ridgway), it is found to thicken to 625 feet. The group being capped by the massive sandstones of the conglomerate No. XII, which weather less rapidly, is generally drift covered.

For convenience of description I have proposed the following sub-division:

Upper shales and sandstones.
Middle sandstone and conglomerate.
(SUB-OLEAN).
Lower shales and sandstones.

The thickness of the entire group varies;

At Bradford it is	247 feet.
" Lewis run it is	250 "
" Hulings well it is	325 "
" Hukill well it is	343 "
" Wilcox wells it is	325 "

At the county line it commences to thicken rapidly to the south and southeast toward Ridgway and Emporium.

At Port Allegheny the group is about 300 feet and at Keating station about 430± feet thick.

§ 107. *Upper Pocono shales and sandstones.*—These strata forming the top member of the Pocono group lie between the OLEAN CONGLOMERATE or more properly the Mauch Chunk, No. XI, and the top of the SUB-OLEAN CONGLOMERATE. In thickness they range from 50 feet in the northern

part of the county to 230 feet at Ridgway in Elk. The greater part of this increase in thickness takes place between the south line of the county and Ridgway. At Kane they are 90 feet, at the Wilcox wells from 100 to 110 feet. North of the east and west line drawn across the county through Clermont the average thickness might be stated to be 60 feet.

The general character of the strata consists of gray and yellow flaggy sandstones and argillaceous shales.

§ 108. SUB-OLEAN CONGLOMERATE forms what I have designated as the middle sandstone and conglomerate member of No. X. This grouping is merely a provisional one and is adopted solely for the convenience of description. It cannot be accepted as a general division of the group* as I have been unable to find any representative of the SUB-OLEAN CONGLOMERATE south-east of a line drawn through Ridgway and Norwich. To the west and south-west it seems to be well defined both in Pennsylvania and Ohio, being the SHENANGO SANDSTONE, this State and the upper Berea in eastern Ohio.†

This middle member consists of a conglomerate or sandstone, sometimes one; sometimes both; sometimes alternations of each.

The conglomerate is composed of a ferruginous, open, angular, loosely cemented sand, containing pebbles varying in size, color and composition, but almost invariably of a flat or oblate spheroidal form. The rock has a tendency to break into strata varying in thickness from a few inches to two or three feet.

The pebbles‡ are readily separated from their matrix and

* In report F, page 206, I divide the Pocono of Huntingdon county into an upper, middle and lower group, which is entirely independent of the division proposed here.

† Report by Mr. M. C. Read, Geology of Ohio, Vol. 1, page 508.

‡ It is an interesting question as to what cause can be traced the peculiarities so characteristic of the pebbles in these two conglomerates. It would be premature to attempt a solution of so important a problem at present. After the area and variations of the conglomerate have been mapped and a careful lithological examination made of their component parts, some light will no doubt be thrown on their origin and mode of transportation.

present a hard, smooth surface, much more so than those to be found in the OLEAN CONGLOMERATE. The quartzite forming the pebbles is more compact, harder and more homogeneous than that of which the pebbles in the latter rock are made.

The sandstone of this member is a hard, massive, fine grained, ferruginous sandstone; oftentimes contains iron balls and has a tendency to break along the bedding, similar to the conglomerate. The sandstone at times is quite shaly and in places is found alternating with shale.

Unlike the upper and lower members of the Pocono it varies comparatively little in thickness. In southern Bradford it has a thickness of 40 feet, changing but little from this generally throughout McKean.

Fine exhibitions of the rock may be seen in the Kinzua valley near the western line of the county.

At Ludlow station on the P. and E. RR. a bold cliff of the conglomerate may be seen immediately south of the railroad.

In the Coburn well it forms the 34 foot sand struck at a depth of 178 feet (stratum No. 6, see section Plate XI). Here it is reported to have contained a "*show of oil.*" The interval between the two conglomerates in this well is 108 feet.

In the Bear creek well* the SUB-OLEAN is possibly represented by strata, Nos. 12, 13 and 14.

In the Silver creek well* by strata, Nos. 9 and 10.

In the Ridgway* section 13 feet of conglomerate is exposed 20 feet above the RR. immediately west of the station.

The conglomerate has been traced in the valley of the Clarion river southwest from Ridgway as far as Millstone.

I have traced it southwest to Tionesta, Forest county, and found it to be the equivalent of the Shenango (Ferriferous) sandstone described in report QQQ, page 60.

§ 109. *Lower Pocono shales and sandstones.* Throughout McKean the general character of the lower member of

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*See Plate XI.

the Pocono is very similar to that of the upper. The sandstones are less massive and more flaggy and the alternations of shales more frequent.

Their thickness various through the central and western part of the county from 150 feet at Bradford to 190 feet along the county line in the vicinity of the Wilcox wells.

Along the B. N. Y. and P. RR., in the southeastern part of the county, they attain a thickness not far from 300 feet.

At the Bear creek and Silver creek wells, Elk county, the thickness of the lower Pocono is about 350 feet. At Ridgway it is 413 feet thick.

§ 110. *Marvin Creek Limestone.* Near the bottom of the *Pocono* a well defined bed of *limestone* has been found to exist in every section of the county where the rocks of this part of the formation are exposed to view.

In southern Bradford township the limestone is exposed along Shepherd run. Here it consists of a hard bluish-gray fossiliferous limestone 2 feet thick. It is overlaid by 25 feet of gray flaggy sandstone and shale; immediately below it are found from 50 to 60 feet of greenish yellow, sandy slate.

The greatest development of this limestone seems to be in the Marvin creek valley.

On the western slope of Chappel hill, in the northern part of Sergeant township, this limestone outcrops along the road, at an elevation of about *2080* feet. Here it is a hard silicious and argillaceous limestone, containing fragments of fossils of Chemung type; it is 5 feet thick. Above it occur 20 feet of green and brownish-gray flaggy and shaly sandstone; below it 60 feet of olive and gray shales and shaly sandstone.

In many places where the bed is not actually exposed fragments of the limestone may be found scattered in the soil, in the vicinity of the outcrop. Weathered portions of the stone present a very peculiar appearance. The lime *leeches out* leaving a silicious skeleton. "Toward the north border of the State, one or two thin layers of partially calcareous rock appear in it, (Pocono) and these contain a few obscure casts of what seem to be bivalve shells."*

*Rogers' Final Report, Vol. II, page 830.

"Not many feet above the red shale (Catskill), and about 200 feet below the bottom of the conglomerate, are found in numerous places evidences of a persistent band of limestone. It occurs, for instance, on the hill side, near the road from Potato creek to Tunamaguont settlement (Bradford), and about 6 miles north of Smethport, where a copious spring issues, charged with lime, which covers the stones and grass with a calcareous tuffa. Similar springs issue upon the Warren road, 6 miles west of Smethport. On Bunker hill, on the Bellefonte turnpike, a specimen of fossiliferous limestone was found occupying this position in the series, under an exposure of very hard whitish Vespertine (Pocono) sandstone, dipping 7° S. S. E.

"The bed itself was discovered beneath a cliff of similar hard whitish sandstone, 30 feet high, upon the run which enters Potato creek from the westward, 10 miles south of Smethport. This limestone is 4 feet thick, exceedingly fossiliferous, very hard, and very sandy, being in reality a sandstone filled with fossil shells. It will sometimes make a sufficiently good lime for agricultural purposes. It seems to have been deposited over a very wide area, as we discovered it upon Bennett's branch to the south; while there can be no good reason to doubt that the same band makes its appearance upon the Tioga river and Pine creek, and even on Towanda creek to the east. It has been recognized also upon the Tunamaguont (Tuna) creek to the north-west."*

This limestone is probably the same as the *Lower Meadville limestone* in Crawford county.

In the Benezette dry hole, Elk county a bed of limestone 7 feet thick was reported at a depth of 123 feet. This is without doubt the same as the *Marvin creek limestone.*

Nowhere has this bed been found of economical value; but from the persistency of its occurrence it forms a very important geological horizon.

§ 111. The dynamical conditions under which the Pocono sediment was deposited must have been quite different from those existing during the deposition of either the *Pottsville* or *Catskill rocks.*

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*Rogers' Final Report. Vol. II, page 548.

A glance at the accompanying illustration Plate XI will show a sudden change in the thickness of the Pocono rocks especially south of the McKean-Elk line. The thickness of the OLEAN CONGLOMERATE, which is the bottom member of the Pottsville, remains constant between Bradford and Ridgway while there is but a slight and very gradual increase, toward the south, in the thickness of the Catskill red beds.

Along a line from Smethport south-east to Sinnemahoning, Cameron county, the thickness of the Pocono formation is as follows:

At Smethport,	250	feet.
" Norwich,	300	"
" Keating station,	400	"
" Shippen "	450	"
" Emporium,	550	"
" Cameron,	550	"
" Driftwood,	700	"
" Sinnemahoning,	750	"

It will be noticed from this table that along this line the thickness of No. X increases gradually to Cameron, when the rate of increase becomes more rapid. If we should draw on a map of McKean, Elk and Cameron a line passing through the points where this sudden change in the thickness takes place it will be found to have very nearly the same position as the indicated axis of the Kinzua-Emporium anticlinal; except having a more direct east and west course.

The conclusions to be deduced from these facts are obvious. We have innumerable evidences of the continued but varying oscillation of the earth crust from the earliest geological times to the present day.

The fact that horizontal sedimentary beds having a constant character and an equal thickness over a wide area, is not necessarily evidence that the sea-bed was absolutely at rest during the formation of the strata through which such conditions prevail. The bottom must have sunk to permit of the deposition of superincumbent sediment. In this case subsidence must have been equable over the area where the conditions of rock structure have remained constant.

A change either in the thickness or character of the strata of a definite group must necessarily indicate variable conditions to have existed during the time of the deposition of the group. Local and comparatively limited changes might be accounted for by variations in the depositing water currents; either in their direction, force or the amount of sediment held in suspension.

A progressive thickening of the group in definite directions cannot be explained in this way; it indicates a variable rate of oscillation in the sea bottom. Such we are compelled to conclude must have been the case at the close of the Catskill and during the Pocono period. South of the line which indicates the sudden change in thickness the sea bottom must have subsided at a greater rate than to the north of it; or north of it the elevation must have been greater than to the south.* In other words a monoclinal was found at the end of the Catskill period which occupied a position very nearly the same as that in which we at present find the Kinzua Emporium anticlinal.

Catskill (Ponent) No. IX.

§ 112. This formation which is the equivalent of the Old Red sandstone, is one of the best defined and wide spread formations in the State. It covers an extensive area in southern New York having its typical development in the Catskill mountains from whence it derives its name.

Its thickest development in this State, is along its extreme south-eastern outcrop, or in the valley north-west of the Kittatinny mountain. At the Lehigh river it measures about 5,000 feet and at the Susquehanna 6,000 feet thick. "Unlike some of the great groups, which gradually assume new phases, by the loss or acquisition of subordinate members, or by mutations in the members they retain, this series undergoes almost no important modification but that of thickness."

It is devoid of economical interest except in western

* Somewhat similar conditions must have existed during the Catskill period but their effects are shown in an entirely different area.

A glance at the accompanying illustration Plate XI will show a sudden change in the thickness of the Pocono rocks especially south of the McKean-Elk line. The thickness of the OLEAN CONGLOMERATE, which is the bottom member of the Pottsville, remains constant between Bradford and Ridgway while there is but a slight and very gradual increase, toward the south, in the thickness of the Catskill red beds.

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" Norwich,	300 "
" Keating station,	400 "
" Shippen "	450 "
" Emporium,	550 "
" Cameron,	550 "
" Driftwood,	700 "
" Sinnemahoning,	750 "

It will be noticed from this table that along this line the thickness of No. X increases gradually to Cameron, when the rate of increase becomes more rapid. If we should draw on a map of McKean, Elk and Cameron a line passing through the points where this sudden change in the thickness takes place it will be found to have very nearly the same position as the indicated axis of the Kinzua-Emporium anticlinal; except having a more direct east and west course.

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The fact that horizontal sedimentary beds having a constant character and an equal thickness over a wide area, is not necessarily evidence that the sea-bed was absolutely at rest during the formation of the strata through which such conditions prevail. The bottom must have sunk to permit of the deposition of superincumbent sediment. In this case subsidence must have been equable over the area where the conditions of rock structure have remained constant.

A change either in the thickness or character of the strata of a definite group must necessarily indicate variable conditions to have existed during the time of the deposition of the group. Local and comparatively limited changes might be accounted for by variations in the depositing water currents; either in their direction, force or the amount of sediment held in suspension.

A progressive thickening of the group in definite directions cannot be explained in this way; it indicates a variable rate of oscillation in the sea bottom. Such we are compelled to conclude must have been the case at the close of the Catskill and during the Pocono period. South of the line which indicates the sudden change in thickness the sea bottom must have subsided at a greater rate than to the north of it; or north of it the elevation must have been greater than to the south.* In other words a monoclinal was found at the end of the Catskill period which occupied a position very nearly the same as that in which we at present find the Kinzua Emporium anticlinal.

Catskill (Ponent) No. IX.

§ 112. This formation which is the equivalent of the Old Red sandstone, is one of the best defined and wide spread formations in the State. It covers an extensive area in southern New York having its typical development in the Catskill mountains from whence it derives its name.

Its thickest development in this State, is along its extreme south-eastern outcrop, or in the valley north-west of the Kittatinny mountain. At the Lehigh river it measures about 5,000 feet and at the Susquehanna 6,000 feet thick. "Unlike some of the great groups, which gradually assume new phases, by the loss or acquisition of subordinate members, or by mutations in the members they retain, this series undergoes almost no important modification but that of thickness."

It is devoid of economical interest except in western

* Somewhat similar conditions must have existed during the Catskill period but their effects are shown in an entirely different area.

Pennsylvania where it contains the *Venango oil sand group* from which almost all the mineral oil of the State was derived until the discovery of the Bradford district.

In McKean the formation undergoes but slight changes in thickness and contains no *oil producing sand.*

Throughout the western and central part of the county the thickness of the group varies little from 250 feet. Between Smethport and Coudersport, Potter county it thickens considerably, being 370 feet thick at the latter place.

At Ridgway, Elk county it is 334 feet and in the Cameron well, Cameron county 347 feet. South and east of a line drawn between these two points the formation thickens rapidly. At Benezette it is 500 feet thick and at Sinnemahoning there is 500 feet outcropping; how much of the formation lies below water level we do not know; possibly from 100 to 200 feet. To the west of Ridgway as far as Tionesta, Forest county the Catskill rocks change very little in thickness but are subject to the same variations in character as in McKean.

In report RR on Cameron, Elk and Forest counties the relation of the *Venango oil sand group* to the Catskill No. IX will be shown and some of the facts bearing upon the dynamical conditions existing during the deposition of these strata will be given.

In McKean the group consists of red and gray slate and shale and fine grained gray sandstone. The coloration of the slate and shale varies considerable, there being more red in the southern and eastern part of the county than there is in the northern and western part.

§ 113. The "*Big Red*" of the Venango and Butler oil wells is the representative of the Bedford red shale of the Ohio sections. It is not represented in McKean. According to a line of sections which I have constructed across Forest county I place the Bedford shale in the lower part of the Pocono, No. X.

Chemung (Vergent.) No. VIII.

§ 114. The Chemung is but the top member of the group

of strata which in Pennsylvania constitute formation No. VIII. It is the oldest member of the Palæozoic age which is known to us in the district.

For convenience of description the rocks of this formation have been grouped as follows:

Upper shales and sandstones.
Bradford oil sand.
Lower shales and sandstones.

§115. *The upper member of the Chemung* might be subgrouped into three parts, an upper gray, a middle red and gray * and a lower gray.

The average thickness of this member may be stated at 1300 feet.

At Bradford it is	1282 feet.
" Lewis run it is	1280 "
" Smethport it is	1305 "
" Ludlow it is	1290 "
" Wilcox wells it is	1300 "

East of Smethport or south of the Wilcox wells its thickness is not known; as no *positive* representative of the Bradford oil sand, which determines its lower limit, has been found.

The average thicknesses of the sub-divisions into which this upper member may be grouped are as follows:

Upper	350 feet.
Middle	300 "
Lower	650 "

The *upper portion* consists for the most part of gray slate, shale and sandstone. In the Dennis well at Bradford it is composed of,

Gray slate, ...	8 feet,
Dark and gray sandstone, ...	45 "
Fine sandstone and slate, ...	216 "
Gray sandstone and slate, ...	61 "
Total, ...	330

* The red shales are no doubt the representatives of those which are found in the Chemung in the vicinity of Mansfield, Tioga county and described as early as 1841 by Prof. Lesley (Report G, page 94).

This section may be taken as an average one of the top of the Chemung throughout the county. The *middle or red and gray* part of the upper member in this same well is represented by the following strata:

Red sandstone,	10 feet.
Dark slate,	20 "
Sandstone and chocolate shale,	63 "
Gray slate and sandstone,	201 "
Red slate and shale,	14 "
Total,	308 "

The amount of red coloring matter which the middle portion contains is exceedingly variable, but seems to increase toward the south and east.

The red is a much duller and deeper color than that of the Catskill rocks.

The red bands at the top are the most constant and are possibly representatives of the upper Mansfield iron ore bed in Tioga county.

They are sometimes so thin and so indistinct that the drillers fail to recognize their presence.

The *lower* strata of the middle member resemble very much in character those found above the red beds. They comprise what the "oil drillers" have chosen to call the *Bradford oil sand group*, containing a *first*, *second* and *third* or oil-producing sand.*

In the Dennis well this part of the group is represented by

Gray sandstone and slate,	36 feet.
Gray and yellow sandstone, *First sand* so-called,	25 "
Gray sandstone and slate,	44 "
Gray slate,	175 "
Brown sandstone,	17 "
Slate,	28 "
Brown and gray sandstone, *Second sand* so-called,	36 "
Gray slate, with occasional sand beds,	283 "
Total,	644 "

The sand beds designated as the First and Second sands are too variable in character and thickness and contain too little petroleum to be called oil sands. In the Tuna valley near State line what is known as "slush oil" has been found

* See general description of the Bradford Oil district.

in the horizon of these sands. The occurrence is however too local to characterize the sands throughout the county.

§ 116. The *Bradford oil sand* is the most important economical stratum in the northern tier of counties.

It consists of a gray and white sand, of about the same coarseness as the ordinary beach sand of the Jersey coast; compact, yet loosely cemented. The average thickness of the sand is about 45 feet, and from top to bottom, the sandy strata change but little in their general character. It is only when specimens from the successive layers are placed side by side and closely examined, that any difference in structure can be recognized. The grains of sand are angular, vary but slightly in size, color and the quantity of cementing material which holds them together in their rock bed.

The same homogeneousness, which characterizes the vertical section, is found to exist over a considerable horizontal area. In fact but little change is found to exist in the sand obtained from wells 15 miles apart, or in the sand from the intermediate wells.

The greatest length of the Bradford district is 18 miles north, 30° east; its greatest width is 12 miles in a north and south direction. The area of the territory is between 100 and 110 square miles. In this area the sand is so regular and constant that if wells were drilled at random the number of dry holes, which would be obtained, would hardly exceed 2 in every 100.

A good productive sand in the Venango group consists of a white, gray or yellow pebble rock; the pebbles being loosely cemented together and generally bedded in fine sand. The rock is open and porous. The interstices between the pebbles and sand grains are extensive and capable of containing a large bulk of oil; but this character does not maintain itself over any extended area. Areas of such sand are small and scattered and are separated by sand beds, possessing a character belonging to the unproductive sands.

The Venango sands are not homogeneous over any considerable area and are frequently very heterogeneous in section. The thickness of the sand varies; in one locality the

upper part of the sand may be pebbly and of productive character and the lower part fine and contain no oil, while but a short distance away the conditions may be reversed.

The difference in the structure of the sands, when considered in connection with their relative productiveness, is a strong argument in support of the view which has been accepted by the *best informed* of our geologists that the sands are only reservoirs or sponges which serve to hold the oil, coming almost entirely from an inferior formation to which it is indigenous.

The conditions under which these two sands were deposited must have been essentially different. The Venango sands were undoubtedly shore and shallow water deposits. The currents, by which the sediments forming the group were transported, were evidently rapid and shifting. It has been suggested that the sands may have been laid down in a river bed. This would necessitate dry land at the time, on either side of the territory where the sands are at present found.

The Bradford sand was possibly deposited in deeper water, by a slower and more constant current. It does not bear any evidences of being a shore deposit, but was probably formed in a bay or estuary.

§ 117. The *lower member of the Chemung* in McKean include all the strata which have been pierced by the drill below the Bradford sand. As far as known they consist of gray slate, shale and sand. In Smethport well (No. 1) 644 feet are reported in the section (Plate XI).

Oil is reported to have been found in a sand 360 feet below the Bradford sand at Smethport and Sartwell. I have called it the *Smethport oil sand*,* although it has never produced any oil.

* The petroleum obtained from the Old Haskill well, in the vicinity of Smethport, was said to come from this lower horizon, and this fact was what induced me to name the rock the *Smethport oil sand*. Recent tests made at this well by Mr. Harmar go to show that the bulk of the oil came from the *Bradford sand*.

Potter County Section.

§ 118. The connection of the stratigraphy of McKean to that of Potter county is clearly defined in Chapter IX, Report of Progress GGG. My general compiled section of the formations found in the western part of the latter county is given here for the sake of comparison.

OLEAN CONGLOMERATE, *Pottsville coal measure conglomerate*, No. XII,	50′
Shales and sandstone representing *Mauch Chunk No. XI*, and *Upper Ponoco, No. X*,	70′
SUB-OLEAN CONGLOMERATE and S. S. *Middle Ponoco, No. X*,	60′

Lower Ponoco, No. X.

Gray shale and S. S. and red shale,	20′
False bedded S. S. and shale,	50′
Gray shale with bands of red shale and slate,	110′
Gray shale and S. S.,	90′

Red Catskill, No. IX.

Red shale containing gray shale and flags,	110′
Gray shale and S. S. *fish beds*,	60′
Red shale with probable alternations of gray and green shale,	200′

Chemung, No. VIII.

Gray shale and S. S. containing *fish beds* in the upper part,	140′ (?)
Olive shale,	30′
Red shale,	5′±

The OLEAN CONGLOMERATE has the same unmistakable character, which it is found to possess generally throughout McKean. A thickness of 50 feet was measured in the vicinity of Coudersport. It seems to vary but little from this throughout the western part of the county.

The *Mauch Chunk Shales of No. XI* increase in thickness to the east of Port Allegheny. Indications of red shale were found in Clara and Eulalia townships. No cannel or coal slates were found in this horizon in Potter county, resembling in any way those seen in the vicinity of Clermont. In Eulalia the thickness of the Mauch Chunk shales would possibly not exceed 30 feet.

The *Pocono, No. X*, shows the same three fold feature that it does in McKean and differs but little in the character of its strata. The sandstone representing the SUB-OLEAN CONGLOMERATE has fined down considerably. The thickness of the group ranges from 350 to 400 feet. At Port Allegheny it is slightly under 300 feet.

The *Catskill, No. IX*, at Coudersport is 370 feet thick, being an increase of about 120 feet from Smethport. The lithology of the group undergoes but a very slight change. The amount of red coloring matter increasing gradually to the east.

No comparison can be made between the *Chemung*, in the two counties, as only 175 feet is shown in the Potter section.

South from Coudersport in the valley of the East branch of Sinnemahoning creek the rocks of No. X, IX and VIII thicken very much. About 4 miles south of the Cameron-Potter line the Pocono formation is 740 feet thick.

CHAPTER VIII.

ECONOMIC GEOLOGY.

The minerals which have proved to be of any economical importance may be grouped under the following heads:

Petroleum, Coal, Natural gas, Building stone, Flagstone, Building brick clay, Fire clay, Limestone, Iron ore, Mineral paint and Mineral water.

Petroleum.

§ 119. It is interesting to know that possibly the first historical mention we have of petroleum (Seneca, mineral or rock oil) being found in the United States is a description of the Cuba oil spring, Allegheny county, New York, but 16 miles north-east of the most recently discovered of the Pennsylvania oil districts, or that known as the Bradford. It is contained in a letter written July 18th, 1627, by the French missionary Joseph Delaroche, who speaks of the spring as a "*Fontaine de bitume.*"*

It has been reported to me that the first well drilled in the Bradford district was drilled by F. E. Dean and brothers in 1865. This well was located on the Shepherd farm, near the present site of Custer City. One hundred and sixty feet of drive pipe was used, and the hole was drilled to the depth of 900 feet.

The *producing sand* at Custer City is found about 1130 feet below the level of the railroad track. The Shepherd farm well was therefore abandoned over 200 feet above the top of the oil sand.

The next well was drilled by the Dean brothers on the Clark farm at Tarport. Drilling was stopped at a depth of 605 feet, or over 400 feet above the top of the oil sand.

*Segard's *Historie du Canada.*

In the year 1862 the old Bradford well, since known as the Barnsdall well, was drilled to a depth of 200 feet with a spring pole, and then abandoned. In the spring of 1866 the citizens of the village of Bradford concluded to club together and sink the Barnsdall well deeper. It was drilled to a total depth of 875 feet, or to within 150 feet of the Bradford *producing sand.* All of these wells were drilled with the expectation of finding the Venango county oil, and at about the same depth below water-level as at Oil City. They were all utter failures, and the old Bradford well, drilled to a depth of 200 feet in 1862, has as much claim to have been the first *oil* well in the Bradford district as any of those which were subsequently drilled by the Dean brothers.

The *first well* sunk to the Bradford sand was drilled by Mr. James E. Butts, Hon. C. H. Foster, and Mr. Job Moses, with a few others, under the name of the Foster Oil Company. This well was situated on the Gilbert farm, two miles north-east of Bradford. "Slush" oil was found at a depth of 751 feet, and the producing sand was struck at 1110 feet in the month of November, 1871. The daily production was 10 barrels. From the time when the sand was found in the Foster Oil Company's well to December, 1874, no wells were drilled that amounted to anything.

On December 6th, 1874, Messrs. Butts and Foster struck the oil sand in what is known as the Butts well, No. 1, on the Archy Buchanan farm, two and a half miles north-east of Bradford. This well started off with a daily production of 70 barrels, and was really the first well that attracted the attention of the oil men to the possibility of finding a profitable oil district in the county.

The unparalled growth of the field is evidenced by the fact that in April, 1880, over two years from the completion of the Butts well, there were 4000 producing wells in the district with a daily average production of 50,000 barrels or about $\frac{1}{1}\frac{8}{9}$ths of the total average daily production during the same month for the whole State of Pennsylvania.

Petroleum is the most important mineral product of the county. A general description of the district in connection

with general statistical facts are given in the latter part of this report.*

Coal.

§ 120. The most northern outcrop of the Appalachian coal basin of the United States is contained in McKean county. This nearness of the coal fields to the northern markets, in western New York and Canada, has, during the past 20 years, attracted an enormous amount of capital which has sought profitable mining investments.

During the war of the rebellion when all the manufacturing and mining industries of the States were stimulated, large areas of the *uplands* of this county were purchased at random, as valuable coal lands. Every one who owned tracts, of any considerable size, had professional reports made by local geologists and engineers and it was generally held, by both speculators and capitalists of good judgment, that the county would some day, at that time not very far distant, become the center of one of the most valuable coal and iron regions of Pennsylvania. How far this hope has been realized, the developments of the past 10 years bear evidence.

A glance at the geological map will show that a considerable extent of territory is underlaid by what has been known as the *Lower productive coal measures.*

Unfortunately for the interests of the county all the coal beds which are contained in this series are not of sufficient thickness, purity, regularity and area as to prove to be coals which can be profitably mined.

The area which is underlaid by these *Lower productive coal measures* very far exceeds the area of the county underlaid by *workable commercial coal beds.* Most of the terri-

* No systematic or detail examination has yet been made of the Bradford district. During the prosecution of my general geological survey of McKean and special examination of the coal basins many facts have been gathered connected with the petroleum interests which have served to determine the general geological features of the district. In this way many important conclusions have been arrived at of great value to the oil producer. It is hoped that an opportunity will be afforded of making a thorough, economical examination of the geology of this important and interesting oil territory.

tory containing what may be termed commercial coal beds, or such as can be worked to a profit, is contained in the five townships of Lafayette, Hamlin, Sergeant, Norwich and Wetmore. Only in Lafayette and Sergeant has coal ever been mined for shipment outside of the county.

The following list comprises all the workable beds:

1. Dagus or Kittanning lower coal,
2. Clermont or Clarion coal,
3. Alton upper } Mercer coals.
4. " middle } Mercer coals.
5. " lower } Mercer coals.

The *Marshburg upper* and *lower coal beds* I do not include in this list as it is hardly probable these beds will ever produce coal pure enough to be profitably mined or shipped.

The *Dagus bed* underlies a very limited area. It has never been mined (see § 80).

The *Clermont bed* has been extensively worked by the Buffalo Coal Company in their mines immediate opposite Clermont RR. station. These are the largest and most profitable mines that have ever been worked in the county.

The same bed has been worked (the mines are now abandoned) at Buttsville, in the Davis hill, Lafayette, and at several localities on the Lafayette plateau between the village of Lafayette and Big Shanty.

In the Howard hill region, quite a large area is underlaid by this bed. The development has been so limited that it is impossible to judge of the value of the coal.

The largest areas underlaid by the *Clermont coal* are to be found in the Clermont and Norwich coal basins. This bed is without doubt the *most important* which has as yet been proved in McKean.

The *Alton coal beds* have an extremely variable character (see § 90). It is a noticeable fact that never has but one of the beds been worked in any one locality.

The *upper bed* has never been mined except at the new mines of the Buffalo Coal Company on Instanter creek.

The *middle bed* has been extensively worked at Alton and is at present being mined by Mr. James E. Butts.

McKean county coals, analyzed by A. S. McCreath.

	Water.	Volatile matter.	Fixed carbon.	Sulphur.	Ash.	Color of ash.	Coke.	Fuel ratio.
1. James E. Butts, Bond Vein; top bench, Alton middle bed,	.670	36.065	48.417	1.058	13.790	gray,	63.265	1:1.34
2. James E. Butts, Bond Vein; middle bench, Alton middle bed,	1.030	37.630	51.237	1.553	8.550	gray,	62.370	1:1.36
3. James E. Butts, Bond Vein; bottom bench, Alton middle bed.	.710	32.980	46.867	2.943	16.500	gray, red tinge,	66.310	1:1.42
4. Buffalo Coal Co., Clermont; Clermont bed,	1.470	38.710	44.561	4.839	10.420	pink,	59.820	1:1.15
5. T. E. Winans, east of Norwich; rock opening,	1.860	34.630	47.304	2 491	13.715	red,	63.510	1:1.36
6. " " " " blue opening,	1.130	33.090	53.006	1.874	10.900	gray,	65.780	. . .
7. " " " " Hamlin opening, top bench,	1.210	36.895	52.593	2.037	7.265	red, gray,	61.895	1:1.42
8. T. E. Winans, east of Norwich; Hamlin opening, bottom bench,	1.060	28.990	35.588	.977	33.385	yellow,	69.950	1:1.22
9. T. E. Winans, east of Norwich; coal pit opening, top bench, Dagus bed,	5.930	36.385	51.673	.677	5.305	cream,	57.655	1:1.42
10. T. E. Winans, east of Norwich; coal pit opening, bottom bench, Dagus bed,	7.710	33.705	55.868	.802	1.915	cream,	58.585	1:1.65
11. T. E. Winans, east of Norwich; spring opening,	1.780	36.270	47.791	5.069	9.090	pink,	61 950	1:1.31
12. Five miles east of Norwich; Rochester cannel opening,	1.330	27.170	26.906	10.259	34.335	lilac,	71.500	1:0.99

The *lower bed* has been opened but has never been worked.

The accompanying table shows the chemical constitution of the several beds as proved at the principal openings in the county.

Specimens from Bond Vein and Clermont represent the average out-put of these two mines, as it is shipped to market. The remaining specimens were taken from out-crop openings and cannot therefore be said to show the true value of the beds from which the specimens have been taken.

Means of Shipment.

§ 121. It would require a very small amount of railroad construction to make all the coal fields of McKean accessible to market. The *Clermont coal basin* has a northern outlet via the McKean and Buffalo RR. from Clermont. It is proposed to continue this road south into Elk and Jefferson counties.

A branch road constructed along Scaffold Lick creek, from the Buffalo, New York and Philadelphia RR. would afford a most admirable outlet to the *Norwich or Potato creek coal basin.*

The Buffalo, Bradford and Pittsburgh RR. runs directly through the center of the *Alton coal basin*; when this road is constructed south into Elk county it will pass directly through the *coal region of Howard hill.*

Natural Gas.

§ 122. Gas may be obtained almost any where in the vicinity of the oil territory. It makes an excellent and economical fuel and illuminant. It is most frequently found coming from the *Bradford oil sand* or the immediate associated strata. Prof. Sadtler of the University of Pennsylvania has made an examination of the gas which is used so extensively for illumination in the city of Bradford. The results are found in the descriptive chapter on the Bradford oil district.

The amount of petroleum and gas found in any special

locality is generally inversely proportional to each other. Where the amount of gas is at a maximum, the amount of oil is at a minimum and *vice versa.*

All the facts which we have bearing upon the durability of *natural gas supply* go to show that the amount is limited. In a single well drilled in a district the pressure of gas will remain constant and the supply maintain a marked regularity for years; but as soon as additional wells are drilled to the *gas stratum* the amount of gas coming from each well gradually diminishes; in the course of years the gas will exhaust itself and the well cease to flow. The wells in the vicinity of the city of Erie show that the amount of gas is limited. Wilcox well No. 1, or the old Adams' well, has been producing gas ever since 1865 without any sensible diminution in the amount. In this case the means of escape is limited in proportion to the amount of gas which is stored in the sand rock.

Building Stone.

§ 123. The rocks of the Pottsville conglomerate series supply McKean county with an admirable building stone. The best and most desirable is that quarried from the JOHNSON RUN SANDSTONE; although it does not excel in quality and durability the KINZUA and OLEAN to be found in some localities.

The JOHNSON RUN ROCK furnishes a fine, even grained stone which is readily broken into prismoidal blocks. It is easily dressed and will receive a good face. It possesses one characteristic which at times adds greatly to its beauty and at other times is a great objection to its use in facing. It is a very ferruginous sandstone. When the iron is evenly distributed through the entire body of the stone it has a very beautiful pink or yellow color. The stone used for the construction of the Thomas Memorial Church at Kane is of this character.

When the iron is irregularly disseminated it gives the dressed stone a streaked and very undesirable appearance. Upon long exposure this feature is heightened by an in-

creased oxidation of the iron. In this condition it frequently has a tendency to fracture along the lines where the greatest amount of iron segregates. This fact may be observed where loose blocks, having this character, have been exposed to the weather for any length of time.

Large areas are covered with loose blocks of Johnson run rock generally throughout the central and southern parts of the county.

The KINZUA CREEK SANDSTONE in some localities has almost the identical character of the Johnson run. As a rule the stone is more irregularly streaked with iron and I do not believe it to stand long exposure as well.

Some of the sandstone strata found in the OLEAN CONGLOMERATE or lowest member of the Pottsville series afford nearly as good a stone as either of the upper members. Its appearance is not as regular. The sand grains are not as fine and are more loosely cemented, which renders the stone more friable. The Pottsville sandstones which are used for building are always quarried from loose blocks found either on the summits, on the slopes or in the bottoms of the valleys. Blocks of desirable stone can generally be found of such a size as to be easily broken and split by the wedge or hammer without the necessity of blasting.

The SUB-OLEAN CONGLOMERATE and sandstone, especially in Hamilton township, makes a very fair building stone. Large masses of it could be quarried in the vicinity of Ludlow.

These strata may be said to include all the good building stones of McKean. Some of the more massive sandstone beds of the Pocono have been quarried in a number of localities and used for foundations and rough rubble work but they will not compare either in strength or durability with the higher rocks.

Flagstone.

§ 124. Portions of the Pocono formation No. X and Catskill formation No. IX furnish an admirable flagging stone. Quarries have been opened in the upper part of No. IX in

the vicinity of Norwich and have produced flagstones which, it is reported, have found a ready sale.

The flagstone character, which some of the strata of these two formations possess, does not seem to be confined to any distinct and well defined horizon and the only way the flagstone bands can be found is by experimental diggings.

Building Brick Clay.

§ 125. Brick is one of the most common, cheapest, useful and durable of our building materials. They are made from plastic clays which consist of silica and alumina in varying quantities. The purer clays contain about 1 part of alumina to 2 of silica; these make a brick which when moulded and baked, shrink, warp and crack, so that it is necessary to mix with the clay an additional amount of silica in the form of sand. If the brick is weak and brittle after burning, the clay contains too much sand and it must be mixed with clay containing a greater amount of alumina.

It is only possible to judge of the quality of the clay, for making a good sound brick, by practical tests.

Good clays for making a fair building brick can be found in most of the deeper valleys in the county. The valleys having an outlet through the Allegheny river at State line (B. N. Y. & P. RR.), the Tuna and the Kinzua creeks contain more widely diffused clay beds than any others. As these beds are not among the stratified rocks but occur in the alluvial drift they are of limited and irregular areas. Their position, extent and thickness can only be found by boring or digging trial shafts or pits The quality of the clay can be best determined by making some bricks and subjecting them to ordinary tests.

Fireclays.

§ 126. Under all the coal beds are to be found beds of fireclay, but very few of them possess any value.

The clay found under the *Clermont coal* on the Buffalo Coal Company's tract has been mined to a limited extent and is said to produce an excellent clay for the manufac-

ture of drain pipe. Very little attention has been paid to the fireclays. It is quite possible that a good clay might be obtained in some localities from the beds occurring in the *Alton coal group.*

Limestone.

§ 127. McKean like most of the counties along the New York-Pennsylvania line contains very little limestone; considering the facilities and cheapness of bringing lime from other sections, that which is found can hardly be said to be of any very great economical value. There are traditionary reports generally circulated through the county to the effect that abundance of limestone occurs, but on account of its being covered with drift it is impossible to quarry it. No importance should be attached to these reports, as there is but one limestone bed in the county from which stone suitable to be burned can be obtained, and that is the *Clermont* or *Ferriferous limestone.*

This bed has never been found except in the Clermont coal basin; the stone is of an inferior quality and furnishes a low grade of lime.

The bed has been stripped along its outcrop on the Wilcox farm opposite Clermont and this is the only place in the county where it has ever been obtained. The outcrop of the bed was located at several points near the head waters of Instanter creek and County Line run. Here it consisted of a hard gray argillaceous limestone.

A poor argillaceous limestone has been found generally throughout the county in the lower part of the Pocono formation: it has never proved of any economical value

Iron ore.

§ 128. No ore of iron has ever been found in McKean county of sufficient thickness, purity, regularity and extent to prove a workable commercial bed.

Large masses of balls of iron carbonate are to be found in certain localities mixed up in the soils derived from the coal

measures; they seem to come from local deposits and not from any persistent bed.

The slates of the *Alton coal group* possibly contain a larger amount of iron than any portion of the series.

Beds of *black band iron ore* have been reported to exist in several localities, especially in Lafayette township. Some of the local reports have gone so far as to furnish estimates of the number of tons of pig iron which could be economically produced from certain properties claimed to contain such ores.

I have never seen a workable bed of black band iron ore in the county.

Prof. D. D. Owen, in reporting on the lands of the Kingsbury estate, says:

"The *black band ore*, interlocked in the shaly space known as the Wilber shales*, yielded by chemical analysis the following results:

Moisture,	.8
Protoxide of iron,	56.25
Carbonic acid,	29.95
Lime,	1.00
Magnesia,	.72
Alumina,	2.00
Insoluble silicate,	6.50
Sulphur,	.025
Bituminous matter, loss, &c.,	2.755
Total,	100.000
Specific gravity of ore,	3.069
Metallic iron,	43.75

"This rich black band ore I estimated to be one foot in thickness, as nearly as I could judge, from a view obtained in the shaft on Lewis run, which was partly filled with water at the time I saw it there. This shaft was afterwards cleared out and inspected by Mr. B. Needham, who reported it to be 18 inches thick."

"This rich black band is overlaid by black band shales, eight inches of which yield 14 per cent. of iron, and 2 feet 11 inches, 5.6 per cent.; the succession being as here shown:"

* Shales of the Alton coal group.

1. Earth,	6′
2. Ferruginous shales,	8′
3. Black band,	2′ 11″
4. Light olive shales,	2′
5. { Black band shale,	7″
{ Light olive shale,	1″
6. Black band ore, yielding 43.75 per cent. iron,	1′ to 1′ 6″

"The analysis of No. 5 gave:"

Insoluble silicates,	53.
Protoxide of iron,	18.
Lime,	1.
Magnesia,	1.45
Alumina,	5.5
Carbonic acid, bitumen, loss, &c.,	21.05
Total,	100.00
Specific gravity of ore,	2.61
Metallic iron,	14.

An iron ore bed is frequently found immediately underneath the OLEAN CONGLOMERATE.

Prof. D. D. Owen has reported analyses of five different varieties of iron ore found in this horizon in what has been called the *Rockwell ore cut*, near the head of Two Mile run, in the northwestern part of Lafayette township. The results are as follows:

Insoluble silicates,	25.00	33.50	38.50	48.50	17.00
Protoxide of iron,	36.00	20.09	23.24	22.61	8.05
Peroxide of iron,	9.99	12.04	12.24	7.86	60.45
Carbonic acid,	24.66	18.00	17.20	16.50	5.70
Lime,	1.50	4.50	2.00	1.50	.50
Magnesia,	1.26	1.40	1.40	1.40	.36
Alumina,	1.00	4.00	3.50	1.50	4.00
Phosphoric acid,	.30	.50	trace.		
Sulphur,	.06	trace.			
Loss, not determined,	.23	.97	1.92	.13	3.94
	100.00	100.00	100.00	100.00	100.00
Metallic iron,	35.00	24.01	27.35	23.10	48.65

Mineral Paint.

§ 129. Some of the more argillaceous shale beds in the lower part of the Red Catskill formation, No. IX, are said to furnish "an excellent pigment of a Spanish-brown color,

which makes, when washed and mixed with oil, a firm and durable paint."

An open cut has been made into such a bed on the D. E. Foster farm, about ¼ mile north of Lewis Run station, at an elevation of 1640 feet; the bottom of the Catskill formation at this point being about 1575 feet above tide.

The bed was covered up when the open cut was visited. and I have never seen any of the paint which has been manufactured.

Mineral Waters.

§ 130. The county contains a great many mineral springs for the water of the most of which medical properties are claimed. It might prove interesting to have had a number of these mineral waters analysed, but the pressure of work in the Survey laboratories would not permit the time necessary to make such examinations.

Waters from two springs were forwarded to Dr. F. A. Genth and the following results reported.

Kane Sulphur Spring.

The following is the analysis of the water:
In one gallon of 231 cubic inches it contains;

1. Carbonate of iron,	0.10256	grains.
2. Carbonate of manganese,	0.01885	"
3. Carbonate of nickel,	1. trace	"
4. Carbonate of magnesia,	0.85329	"
5. Carbonate of lime,	4.77934	"
6. Carbonate of potash,	0.45511	"
7. Carbonate of soda,	1.43876	"
8. Sulphate of lime,	0.06820	"
9. Phosphate of lime,	0 01166	"
10. Chloride of lithium,	trace	"
11. Chloride of sodium,	0.77502	"
12. Alumina,	0.02695	"
13. Silicic acid,	0.60176	"
14. Carbonic acid free and half combined,	3.18630	"
15. Sulphuretted hydrogen,	trace	
Total,	12.31780	"

This spring is located on the Emma Hobbs' tract* in the

*Lot 303, warrant 2587.

valley of Hubert run 2½ miles north-west of Kane. The elevation of the spring is about 400 feet below the RR. station at Kane. The water issues from the gray shales below the SUB-OLEAN CONGLOMERATE. The spring is not far above the bed of the stream and the mineral water must be considerably diluted. No means have ever been adopted to protect the spring.

For the convenience of study and comparison the above analysis may be placed under the following form:

1.	Ferrous oxide,	.06366	grains.
	Carbonic acid,	.03890	"
2.	Manganous oxide,	.01164	"
	Carbonic acid,	.00721	"
4.	Magnesia,	.40633	"
	Carbonic acid,	.44696	"
5.	Lime,	2.67643	"
	Carbonic acid,	2.10291	"
6.	Potash,	.29124	"
	Carbonic acid,	.16387	"
7.	Soda,	.84154	"
	Carbonic acid,	.59722	"
8.	Lime,	.02808	"
	Sulphuric acid,	.04012	"
9.	Lime,	.00632	"
	Phosphoric acid,	.00534	"
11.	Sodium,	.30471	"
	Chlorine,	.47031	"

The water was collected October 9th, 1879.

Kane "Geyser Well" Water.

The well from which this water comes is known as the Ernhout and Taylor well, No. 2. It is situated in the south-eastern corner of warrant 3215, Wetmore township, but a short distance to the east of the P. & E. RR. at Sergeant station.

This well was drilled to a depth of 2000 feet. All the surface (fresh) water was cased off at a depth of 364 feet. At 1990 feet a heavy "vein" of mineral water was encountered which was obtained in its pure state as long as the surface water was shut off. After the well was abandoned from failure to find petroleum the casing was withdrawn and the surface water allowed to flow into the hole.

If the mineral water should prove of value for medicinal purposes, it is hoped the well may be recased and the water from a depth of 1990 feet obtained in its pure condition. The water which was analysed was procured before the casing was drawn.

The specific gravity of the water is 1.1418.

In one gallon of 231 cubic inches it contains:

	Per cent.	Grains.
Silicic acid,	.00081	.47323
Ferrous carbonate,	.01330	7.77026
Manganous "	trace	trace
Magnesium "	.00061	.35638
Calcium "	.00707	4.13857
Calcium sulphate,	.06059	35.39849
Calcium phosphate,	.00013	.07595
Magnesium bromide,	.13107	76.94306
Magnesium iodide,	.00150	.87634
Ferric chloride,	.00427	2.49466
Magnesium "	.95159	555.94743
Calcium "	4.91470	2,871.31518
Lithium "	.00455	2.65825
Sodium "	11.05022	6,455.87003
Potassium "	.00450	2.62903
Total,	17.14491	10,016.94686

The water was collected by Mr. M. M. Schultz of Wilcox. The elevation of the top of the well is *1730* feet; so that the mineral water occurs at a depth of 260 feet below ocean level.

REPORT OF THE PROGRESS

OF THE

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA

IN

McKEAN COUNTY

BY CHAS. A. ASHBURNER.

PART II.

DETAILED GEOLOGY OF THE SEVERAL TOWNSHIPS.

Introduction.

The descriptive geology of the several townships in the county is given in the following order:

Group I.

1. Norwich,
2. Sergeant,
3. Hamlin,
4. Lafayette,
5. Wetmore.

Group II.

6. Corydon,
7. Bradford,
8. Otto,
9. Eldred,
10. Ceres,
11. Annin,
12. Hamilton,
13. Keating,
14. Liberty.

Group I includes those townships which contain the largest and most important coal areas, while Group II embraces those containing little or no coal of commercial value.

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Chapter IX.

Norwich Township.

§ 131. Norwich lies east of Sergeant, south of Keating and Liberty, and occupies the extreme south-eastern corner of the county. The southern part of the township is bounded on the east by Potter county, and on the south by Cameron county.

The topography of the township divides it into two parts; the western and larger part drained by Potato creek and its branches, flowing north and emptying into the Allegheny river at Larabee; and the eastern or smaller part, drained by Sinnemahoning creek and its branches, having a general southerly direction, discharging their water ultimately into the Susquehanna river, (West Branch.)

The highest elevation measured, is the Norwich Hill, near the center of the township; its height is 2348′ above ocean level. The lowest point is where Potato creek crosses the northern boundary line at an elevation of 1500′±.

§ 132. The township is traversed by two anticlinal axes, Emporium or Third, and Norwich or Fourth; and by two synclinal axes, axis of the Norwich or Fourth Bituminous Coal Basin, and axis of the Clermont or Fifth Bituminous Coal Basin.*

The axes were all located from careful dip determinations. They are very nearly parallel, having approximately a due north-east and southwest direction.

§ 133. The general dips of the coal measures have been determined from an estimation of the elevation of the bottom of the Olean conglomerate, as given in the following table:

*While the geological map of the county was going through the press and too late for correction, the following error was discovered, viz: Clermont—*Fifth* Basin (instead of Fourth,) and Norwich—*Fourth* Basin (instead of Third.)

At ¾ mile N. W. of Keating station,	*2275′*
" Walcott and Comes creek summit,	*2225*
" Norwich Hill (western side),	2130
" Havens brook summit,	*2125*
" Well No. 3, Rocky run,	2120
Near Well No. 1,	2100
" Well No. 4, Brewer run,	1980
At headwaters Indian run,	*1955*

Potato Creek Coal Basin.

At head of Lost run,	2070
" Block coal opening,	2000
" Rochester cannel coal opening,	1940
" Lyman Camp coal opening,	1925
" Burnt Hill cannel coal opening,	1915
" Blue coal opening,	1910
" Splint coal opening,	1910
" Burdick Hill,	1910
" Coal-pit coal opening,	1905
" Spring coal opening,	1905
" Hamlin coal opening,	1890

The elevations are not given with a view to their geographical position, but in the order of their relative heights. The highest observed elevation of the bottom of the OLEAN is ¾ mile N. W. of Keating station, while at the Hamlin coal opening it lies lower than at any other point where its position was determined.

The maximum dips in the township are on the eastern side of the Norwich (Fourth) basin. The average dip from the summit, ¾ mile north-west of Keating station, to the Lyman Camp opening, which is directly in the center of the basin, is 140′ per mile; of course, the dip gradually diminishes from the former to the latter point, so that the north-west dip at Keating station must be 200′ to 250′ per mile. At the coal opening the rocks lie nearly horizontal.

The measures in the center of the basin have a gradual dip to the south-west. From Lyman Camp opening to Hamlin opening it is at a rate of 11′ per mile, while be-

tween the Hamlin and Burnt Hill cannel openings it is 18′ per mile.

On the eastern side of the basin the dip from Norwich Hill to the Splint opening is 110′ per mile.

The south-eastern dip in the south-western corner of the township is 132′ per mile. In the eastern side of the basin the south-western dip, between Wolcott-Comes creek summit to Well No. 1, is at the average rate of 22′ per mile.

The *general average dip per mile* of the coal measures in the township has been *roughly estimated* from the elevation of the conglomerate.

Table of Dips.

FROM	TO	Distance in miles.	Direction.	Average rate of dip per mile.
Norwich Hill, ...	Splint opening, . . .	2	S. 64° E	110
Block opening, ...	Blue " . .	⅞ (4880′)	S. 65½° E.	100±
Blue "	Hamlin " . . .	5/16 (1600′)	S. 76½° E.	64
Coal-pit "	" " . . .	1¼	S. 40½° W.	12
Rochester cannel opening, . .	Coal-pit " . . .	1½	S. 44½° W.	24
Lyman Camp opening,	Hamlin " . .	3⅛	S. 58½° W.	11
Hamlin "	Burnt Hill cannel opening, ...	1⅜	S. 53° W.	18
¾ mile N. W. of Keating station, .	Layman Camp open'g,	2½	N. 81° W.	140
Havens brook summit,	Indian run, ...	1½	S. 85° W.	113
Well No. 3, . . .	" "	1¼	N. 40° W.	132
Wolcott-Comes creek summit, ...	Well No. 1, ...	5¾	S. 52° W.	22

The magnetic bearings are estimated from the meridian of 1793 and 1794.

The coal beds in Norwich are subject to local dips, as at Howard Hill, Alton, and Clermont; so that the dips which are given in the table cannot be depended upon absolutely as guide dips for the location of coal openings.

§ 134. The strata actually outcropping in this township extend from the shales over the *Dagus coal* bed, (Coal-pit opening, Potato Creek coal basin,) vertically downward for a distance of 1240′ to the UPPER CHEMUNG SHALES AND

SANDSTONES exposed along the B. N. Y. and P. RR., in the valley of Sinnemahoning Portage creek.

The rocks are all of Carboniferous and Devonian age, and are sub-grouped, as follows:

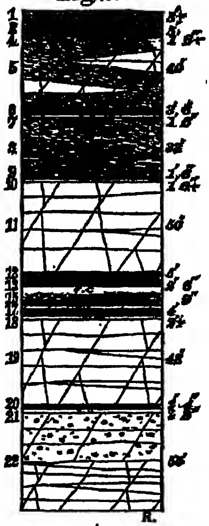
COAL MEASURES, (including the conglomerate,)	290′
MAUCH CHUNK, No. XI, } POCONO, No. X, }	450′
RED CATSKILL, No. IX,	300′
*CHEMUNG, No. VIII,	200′+
Total,	1240′

§ 135. The coal measures in the Potato Creek coal basin (Plate No. 14) have many features common to the entire county, although some of the minor features are characteristic of this locality.

Their total thickness from the bottom of the OLEAN CONGLOMERATE to the highest stratum overlying the limited area of the *Dagus coal* at the Coal-pit opening, is about 290′, in section, as follows:

1.	Shales,	15′±
2.	Gray slate,	3′
3.	*Dagus coal* (Coal-pit opening),	5′
4.	Fireclay,	1′ 6″±
5.	Shale and sandstone,	40′
6.	Coal (Rock opening),	3′ 6″
7.	Fireclay,	1′ 6″±
8.	Shale and slate,	33′
9.	*Clermont coal* (Charley and Taylor opening),	1′ 6″
10.	Fireclay,	1′ 6″±
11.	JOHNSON RUN SANDSTONE,	50′
12.	Black slate,	5′
13.	*Alton Upper coal* (Spring opening),	2′ 6″
14.	Fireclay and shale,	8′
15.	*Alton Middle coal*,	9″
16.	Shale and sandstone,	4′ 3″
17.	*Alton Lower coal* (Hamlin opening),	4′
18.	Fireclay,	2′±
19.	KINZUA CREEK SANDSTONE,	48′
20.	*Marshburg Upper coal* (Block opening),	2′ 4″
21.	Fireclay,	2′ 8″±
22.	OLEAN CONGLOMERATE AND SANDSTONE,	55′

Fig. 2.



* On account of the strong dips along the Third axis, in the southeastern part of the township, it is impossible to make an exact estimate of the CHEMUNG strata exposed above water-level; their thickness is possibly from 150′ to 250′

This section was originally constructed by myself during the progress of a survey which was made of the Potato Creek coal basin, by Mr. F. E. Gleason, in the summer of 1876. The measurements were afterwards verified during the completion of the survey, by George W. Rafter, C. E., in the summer of 1877.

§ 136. The *Dagus coal*, which is the highest bed found in the basin, has been proven only in one locality; at the Coal-pit opening, elevation 2175′* above tide. Here the following section was measured: (Fig. 6):

1. Gray slate,	4′
2. Black smut,	9′
3. *Coal*,	2′ 5″
4. *Coal*,	3″
5. *Coal*,	2′ 1″
6. Yellow and gray fireclay,	1′ 6′ ±

This coal is generally known as a 5′ bed. The black smut at the top of the bed may become coal under a good cover. Where the bed was opened and examined it was near the outcrop, and had but little cover.

The middle coal bench, which is 3″ thick, has every indication of becoming bony.

The color of the coal is a dull brownish black, and has an irregular fracture. From an examination made of a specimen, by Mr. Rafter, it is reported to be non-coking. Judging from its physical features, it is probably one of the best coals in the basin, but unfortunately it has an extremely limited area, as may be observed from the topographical map (Plate XIV).

The *Dagus* underlying shales and sandstones have the same general character as elsewhere observed.

§ 137. That portion of the section from 15′ above the Rock opening downward to the Splint opening was measured on a steep slope at a location indicated on the map.

Immediately above the Rock opening, 15′ of flaggy sandstone and shale was exposed, the bed being (Fig. 3):

* Eight feet must be added to all the elevations given in the Potato Creek coal basin, to reduce them to the corrected datum of the McKean and Buffalo RR.

1.	Flaggy sandstone and shale,	—
2.	*Coal,*	2′ 6″
3.	Slate and clay,	1″±
4.	*Coal,*	11″
5.	Fireclay,	—

The coal of this bed, especially that from the upper bench, has a black color and a cubical fracture.

The following analysis was made by A. S. McCreath:

Water @ 225°,	1.860
Volatile matter,	34.630
Fixed carbon,	47.304
Sulphur,	2.491
Ash,	13.715
	100.000
Coke, per cent.,	63.510
Color of ash,	red.
Fuel ratio,	1:1.36

The specimen examined was generally coated with silt; had a dull black luster on fresh fracture, and showed numerous thin partings of slate and iron pyrites.

The elevation of the Rock opening is 2130′; so that if this bed should prove a workable commercial coal, the area which would be underlaid by it would be quite limited. The dip of the strata from the Rock opening southeast toward the center of the basin is on an average about 1¼′ per 100′.

On account of the absence of the *Clermont* (*Ferriferous*) *limestone* in this basin, it was a problem of considerable difficulty to properly identify the several coal beds with those found at Clermont, Alton, and in Elk county. The solution, as indicated in the section already given, seems to be the only possible one. The Hamlin coal bed lies directly on top of the KINZUA CREEK SANDSTONE, and the bottom of the OLEAN CONGLOMERATE was determined directly east of the opening. There seems to be no question as to the identity of the coals opened at the Splint and Hamlin openings; so that the Charley seam, which is immediately above the Splint opening, and directly on top of a sandstone (JOHNSON RUN), must naturally be the representative of the *Clermont coal bed.* On this basis the Rock opening, which

is 36′ above the Charley, would be in the horizon of the *Clermont limestone*. In this event the Rock seam may be the representative of the *Scrubgrass coal*, which is found immediately underlying the *Ferriferous limestone*, which itself has no representative in the basin.

§ 138. The *Clermont coal*, which has been drifted on in but one place, at the Charley opening, is but 1′ 6″ thick near the outcrop. When visited the roofing rocks were very much broken up and fractured, and the coal bed seemed to have been crushed and contorted so that it was impossible to form a correct opinion as to the value of the bed. If this coal be the representative of the *Clermont*, as we believe it is, under a good cover, it would possibly attain a greater thickness than 1′ 6″. The coal is very friable, having an irregular fracture and black color.

§ 139. The interval (56½′) between the Charley opening and next underlying coal bed is filled, principally, by a hard ferruginous sandstone, which is the representative of the JOHNSON RUN SANDSTONE.

§ 140. The *Alton coal group* is clearly and boldly defined in the Potato creek basin. Its aggregate thickness is about 20′, and it contains the three coals which are so generally found throughout McKean, Elk, and Cameron counties. The group has a marked feature, which distinguishes it from the same series in the Alton basin. Here the *Alton Middle coal* has the minimum thickness, while in the Alton basin the middle coal has the maximum development. In the Clermont basin only two coal beds are found in the group.

The *Alton upper coal bed* has been opened at the Blue, Spring and Rochester cannel openings.

The Blue opening is 2020′ above tide, and the bed is reported as composed of two benches, the upper bench showing 2′ of coal. The opening had fallen shut when visited, but a specimen of the coal was procured. It had a dull luster, was very hard, contained pyrites and slate, and was coated with silt. The specimen yielded on analysis (A. S. McCreath):

Water,	1.130
Volatile matter,	33.090
Fixed carbon,	53.006
Sulphur,	1.874
Ash,	10.900
	100.000
Coke, per cent.,	65.780
Color of ash,	gray, with pink tint.

The elevation of the Spring opening is 2035′. At this point the bed was not seen, as the opening had fallen shut. Its thickness was reported to be 2′ 6″.

The Rochester cannel opening is near the headwaters of Scaffold Lick creek. The elevation of the bottom of the coal is 2071′. The bed is reported to be 2′ 10″ thick, and to consist of a black, non-coking cannel coal with a conchoidal fracture.

The *Alton middle coal* is but 9″ thick and was seen in but one place directly over the Hamlin opening.

The *Alton lower coal bed* has an average thickness of 4′, and has been drifted on at the Hamlin, Splint and Lyman Camp openings.

At the Hamlin opening the following section was exhibited: (Fig. 8):

1. Gray slate and shale.	—
2. Black slate,	4″
3. Coal,	2′ 3′
4. Black slate,	1′
5. Coal,	1′ 4′
Fireclay,	—

The coal from the upper bench was for the most part coated with silt, has a deep black luster on fresh fracture, is very hard and compact, and shows considerable pyrites in minute crystals. On analysis it gave (A. S. McCreath):

Water, at 225°,	1.210
Volatile matter,	36.895
Fixed carbon,	52.593
Sulphur,	2.037
Ash,	7.265
	100.000
Coke, per cent.,	61.895
Color of ash,	reddish gray.
Fuel ratio,	1:1.42

The coal from the lower bench has a dull, dirty appearance, being for the most part coated with silt and iron oxide. It carries considerable slate and small lenticular masses of white sand rock. When analysed, it gave:

Water, at 225°,	1.060
Volatile matter,	28.990
Fixed carbon,	35.588
Sulphur,	977
Ash,	33.385
	100.000
Coke, per cent.,	69.950
Color of ash,	yellowish white.
Fuel ratio,	1:1.22

This is certainly a worthless coal on account of the high percentage of ash.

§ 141. The coal beds, in the Potato creek basin, have not been sufficiently developed to make a final statement as to their commercial value.

The *Dagus coal* has but a limited area in the vicinity of the Coal-pit opening; so that the value of the basin must depend largely upon the area, thickness and quality of the *Clermont* and *Alton coal beds*. The percentage of ash and sulphur in these coals is large. (See page 107.)

§ 142. Mr. George W. Rafter, civil engineer, of Rochester, New York, in April, 1877, made a carefully prepared report to Ira Winans, Esq., on the quality of the coals from this basin. Some of his results are valuable and interesting; the following extract is republished for reference.

Mr. Rafter gives a detail description of the methods employed by Professor W. R. Johnson in making tests of American coals, in 1844, for the United States Navy Department.

"In testing the McKean county coals it was obviously impossible to burn them in as large quantities as Professor Johnson did. Indeed, the small amount of each specimen furnished rendered it a question of importance exactly how a test of evaporative efficiency should be made. After some consideration of the question, I designed a small furnace and boiler to correspond, so arranged as to render it

possible to burn 5 lbs., thereby obtaining the relative efficiency of the different coals."

"The furnace was constructed of two lengths of vitrified sewer pipe, one six inches inside diameter and the other nine inches. These stood upon a foundation of brick work, with suitable ash-pit and grate, the six inch pipe inside the nine inch, the space between them filled with a non-conducting substance, namely, plaster of Paris."

"The boiler was vertical in form, with all the heating surfaces inclined."

"The area of grate was to area of heating surface of boiler as 1 to 39.5."

"The capacity of the boiler was twenty pounds of water, the greatest amount in boiler at any one time being eighteen pounds."

"The absolute efficiency was obtained as follows: Fair, average specimens of three varieties of coal tested by Professor Johnson, namely, Lehigh and Lackawanna anthracites, and Blossburg semi-bituminous, were tested in this small furnace in same quantities as the McKean county coals, and the relation of their efficiency in this furnace to to that of Professor Johnson noted. In this way the efficiency of this furnace compared with Professor Johnson's was obtained."

Designation of Coal.	Amount from 212°, by Johnson's test, in pounds.	Amount from 212°, by my test, in pounds.	Difference in pounds.	Ratio of first to second.
Blossburg,	9.72	7.10	2.62	0.730
Lehigh,	8 93	7.04	1.89	0.799
Lackawanna,	9.79	5.79	2.20	0.775
				3)2.304
Mean ratio,				0.768

"The accompanying table shows, first, number of pounds of water evaporated by a pound of coal, according to Pro-

fessor Johnson's tests; second, the same fact according to my tests; the third column shows difference between the two in pounds; and the fourth shows ratio of one to the other."

"The mean ratio of the three tests is seen to be, then, 0.768. This is taken as the ratio of efficiency of these tests in terms of Johnson's tests."

"The amount of kindling used was eight ounces of dry hemlock, except with the anthracites, where sixteen ounces were used."

"The following table shows the results obtained:

Column (1) gives the time to 212° from the initial temperature, which varied from 46° to 54°, the amount of water in boiler at beginning of test being uniformly 17 lbs. This column shows at once the relative values of the coals for getting up steam quickly. Column (2) shows the amount of water evaporated from the initial temperature in first hour, while column (3) shows the amount which would have been evaporated with an initial temperature of 212°, and with feed water at same temperature. (4) gives the amount of unconsumed fuel from 5 lbs. and shows relative completeness of combustion. (5) gives amount of fuel actually consumed, and is 5 lbs. minus the quantity in (4). Column (6) shows the amount of water in pounds evaporated by a single pound of fuel during the whole test, while column (7) shows the amount a pound of coal would evaporate under the conditions of Professor Johnson's tests. Column (8) gives time required for combustion, in hours, said time reckoned from lighting of fire to complete extinction by dying away. Column (9) gives average temperature of draft, obtained by inserting a thermometer in smoke flue just outside the boiler, readings being taken every half hour. This column gives an opportunity for judging of the intensity of combustion. Columns (10) to (14) give analysis of coals. Column (15) gives weight of a cubic foot of coal, deduced from weight of accurately made inch cubes. Columns (16) and (17) give ratios of importance in estimating the relative efficiencies of the coals."

Designation of Coal.	Time to 212°, in minutes.	Amount actually evaporated in first hour, in pounds.	Amount from 212°, in first hour in pounds.	Amount unconsumed fuel from 5 lbs., in pounds.	Amount fuel actually consumed, in pounds.	Am't water, in pounds, from 212°, per lb. of coal actually consumed.	Amount water from 212°, in terms of Johnson, per lb. of fuel, in pounds.	Time required for combustion of coal, in hours.	Average temperature of draft.	Proximate Analyses. Percentage of water.	Percentage of volatile matter.	Percentage of fixed carbon.	Percentage of ash.	Percentage of coke.	Weight of a cubic foot, in pounds.	Ratio of volatile matter to fixed carbon.	Ratio of ash to fixed carbon.
Coal Pit,	10	9.51	12.78	0.10	4.90	5.47	7.13	3.25	452°	5.028	31.329	56.236	7.406	63.642	.	1.79	7.59
Spring Seam,	31	2.92	5.83	0.37	4.63	5.92	7.58	3.89	412°	1.142	31.514	59.366	8.201	67.343	83 69	1.89	7.24
Hamlin Seam,	20	6.30	9.89	0.18	4.82	6.47	8.42	3.41	421°	1.128	29.629	61.698	7.544	69.242	80.53	2.08	8.18
Blue Seam,	15	4.13	7.51	0.29	4.71	6.13	7.99	3.75	325°	0.057	30 915	62.171	6.857	69.028	...	2.01	9 07
Rock Seam,	28	4.00	6.86	0.09	4.91	5.60	7.29	3.91	332°	1.557	28.415	58.014	12.014	70.028	...	2.07	4 83
Lyman Camp Seam,	13	8.25	11.77	0.12	4 88	5.55	7.23	3.00	561°	2.557	28.885	57.570	11.814	68.885	92.32	1.99	5.09
Charley Seam,	15	6.75	10.28	0.13	4.87	4.25	5.53	2.41	368°	5.957	29.829	49.229	14.985	64.214	..	1.65	3.29
Block Coal Seam,	17	5.75	9.36	0.07	4.93	4.22	5.49	2.41	411°	2.700	35.786	38.878	22.636	61.514	84.42	1.08	1.70
Burnt Hill Cannel Seam,	12	5.50	9.16	0 06	4.94	4.52	5.88	3.00	373°	3.271	30.385	48.143	18.200	66 343	82 94	1.59	2.65
Rochester Cannel Seam,	22	4.60	7.95	0.73	4.26	3.42	4.45	2.50	425°	0.492	23.579	37.750	38.178	75 928	110.31	1.60	0.99
Buffalo Coal Company,	15	6.13	9.89	0.16	4.84	6.74	8 77	3.33	411°	...	...	...	...	...	...	...	...
Briar Hill Coal,	16	5.50	9.24	0.11	4.89	6.03	7.85	3.66	375°	...	...	...	...	...	...	...	...
Blossburg Coal,	17	5.50	9.29	0.29	4.71	7.10	9.72	3.83	387°	...	...	...	...	...	...	...	...
Coke (from Spring, Hamlin, and Blue Seams),	23	5.50	9.02	0.27	4.73	6.22	8.10	3.16	452°		.	.	11 685	.		.	.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)

"In considering the results of the tests, it must be remembered that the weathering of these coals is not that due to merely a short exposure, but coming as they invariably do from the out-crop, the weathering has proceeded for a long series of years, during which time many valuable properties must certainly have been lost."

"This is by no means a matter of theory merely, for experiments have been made showing that by exposure to the weather for a year only, chemical changes take place seriously affecting the heating powers of coal."

Gas Tests.

§ 143. "Gas works on a small scale were designed, and from one to two pounds of each specimen of coal distilled. The works were modeled after larger works, as regards proportions of condenser, scrubber and purifying box."

"Gas determinations must always involve two elements, namely, quantity and quality. Neither can give any idea of the value of a coal for gas-making without a statement of the other."

"The process of purification was what is known as the dry lime process, in which the gas, after thorough washing with water in the scrubber, is passed through fresh lime."

"The photometric determinations were made with a photometer identical in principle to that described at page 48 of Bowditch's 'Analysis, Technical Valuation, Purification and Use of Coal Gas.'"

"The results are the means of several distillations in each case, and are reduced to the uniform basis of 5 cubic feet of gas per hour, burned in comparison with a sperm candle consuming 120 grains of sperm per hour."

"The first column of the following table shows the number of cubic feet of gas obtained from one pound of coal; the second gives candle power under the conditions just described; the third column the number of grains of sperm equivalent to the gas from a single pound of coal, while the fourth shows density of gas as determined by Goodwin's effusion method, where common air at 60° is taken as unity."

with my own surface observations made on the ground. I regard them to be unreliable, and to show nothing from which a just opinion could be formed as to the *number*, *thickness*, or *value* of the several coal beds which are reported to have been pierced by the drill. They are, however, published here for reference, and I have presumed to put a construction upon them to *indicate at least* the probable geologic position of the strata which have been more or less *minutely described.*

In the vicinity of each hole I have endeavored to determine the *probable* position of the *Clermont coal bed*, from observations made on the JOHNSON RUN and KINZUA CREEK SANDSTONES, and OLEAN CONGLOMERATE.

§ *146. Well No. 1 (Fig. 11).*

Estimated elevation of the *Clermont coal bed*=2200′. Well mouth above ocean in feet=(894′+1338) 2232′.

1. Soil, &c.,	5′	3′	to	5′	3″
2. Olive shales,	14′	9″	to	20′	
3. Hard rock, containing 2 in. red sand,	5′		to	25′	
4. Shale rock,	3′		to	28′	
5. Black slate,	10′		to	38′	
6. Red sandrock, very gritty,	4′		to	42′	
7. White SS.,	3′		to	45′	
8. Slate,	8′		to	53′	
9. SS.,	7′		to	60′	
10. Slate,	1′		to	61′	
11. *Coal*,		6″	to	61′	6″
12. Iron ore,		6″	to	62′	
13. Yellowish-gray SS., very hard,	1′		to	63′	
14. Sandrock,	12′		to	75′	
15. Dark sandrock,	8′		to	83′	
16. Dark rock, not much grit,	7′		to	90′	
17. Dark rock and slate, with particles of coal,	1′		to	91′	
18. Fireclay, 19. Dark rock,	4′		to	95′	
20. Dark rock,	5′		to	100′	
21. White sandrock, very hard,	4′		to	104′	
22. Sandrock, softer, whiter,	12′		to	116′	
23. Sandrock, very white,	14′		to	130′	
24. White, fine, micaceous sandrock,	—			—	

The elevations of the wells on the Backus and Chadwick lands were determined by Mr. N. F. Jones, civil engineer.

Fig. 3. p. 101.
Rock opening coal bed.

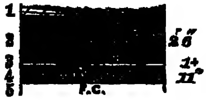


Fig. 6. p. 100.
Dagus bed. Coal pit opening

Fig. 8. p. 103.
Alton Lower coal bed. Hamlin opening.

Fig. 4. p. 102.
Clermont coal bed. Charley opening.

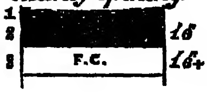
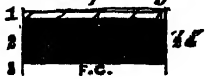


Fig. 9. p. 99.
Marshburg Upper coal. Block opening.



Alton Upper Coal bed.

Fig. 5. p. 103.
Spring opening.

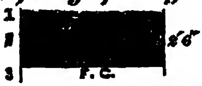


Fig. 7. p. 102.
Blue opening.

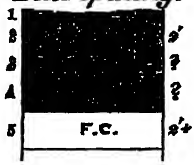
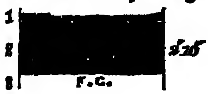
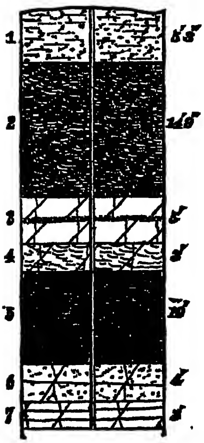


Fig. 10. p. 103.
Rochester cannel opening.



Butterfield Purchase Well No. 1.

Fig. 11. p. 110.



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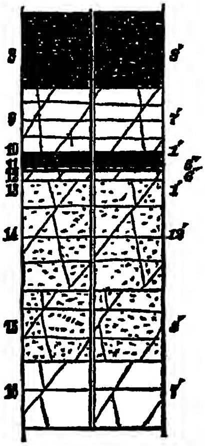

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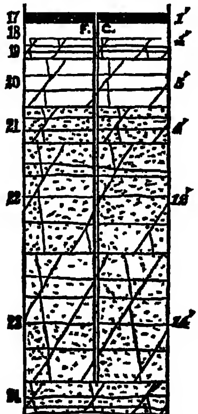

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The difference in the datum of Mr. Jones' survey and that of the Buffalo Coal Co. was ascertained by Mr. Graham Macfarlane.

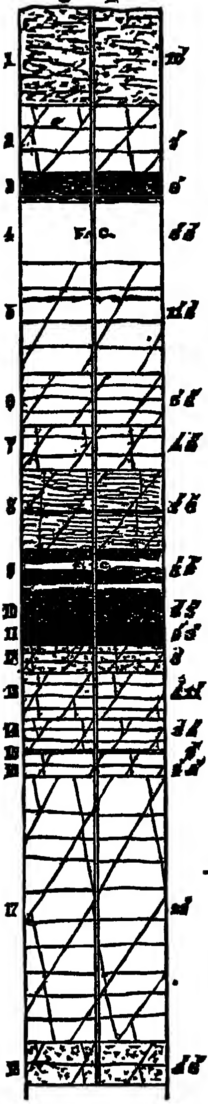
§ *147. Well No. 2 (Fig. 12).*

Estimated elevation of the *Clermont coal bed*=2163'. Well mouth above ocean in feet=(894+1338) 2229.

1.	Earth,	10'		to	10'	
2.	Coarse, yellow, sandstone,	7'		to	17'	
3.	Blue slate, particles of coal,	3'		to	20'	
4.	Fireclay,	6'	6"	to	26'	6"
5.	Rock, with small lumps of coal at 30' 6",	11'	6"	to	38'	
6.	Dark rock,	5'	6"	to	43'	6"
7.	Yellow SS.,	4'	6"	to	48'	
8.	Soft slate rock, containing small seam of coal,	7'	6"	to	56'	6"
9.	Dark slate, mixed with fireclay,	5'	3"	to	61'	9"
10.	Dark brown slate,	2'	3"	to	64'	
11.	*Coal*,	2'	3"	to	66'	3"
12.	Soft, gray sandrock,	3'		to	69'	3"
13.	Buff SS.,	4'	11"	to	74'	2"
14.	Dark SS.,	3'	4"	to	77'	6"
15.	Mud,		2"	to	77'	8"
16.	Dark SS.,	2'	4"	to	80'	
17.	Light gray SS.,	28'		to	108'	
18.	Coarser sand,	4'	8"	to	112'	8"
19.	Dark SS.		6"	to	113'	2"
20.	*Coal*,	2'	9"	to	115'	11"
21.	Slate rock, with fireclay,	3'	7"	to	119'	6"
22.	Light rock,	2'		to	121'	6"
23.	Dark shale,	7'	6"	to	129'	
24.	Slate, with a little coal,	4'	11"	to	133'	11"
25.	Dark rock,	2'	1"	to	136'	
26.	Hard rock,	1'		to	137'	
27.	Soft, muddy rock,	9'		to	146'	
28.	*Coal*,	1'		to	147'	
29.	Sand rock,	3'		to	150'	
30.	Black slate rock,	3'	6"	to	153'	6"
31.	Gray sandrock,	8'	6"	to	162'.	
32.	Dark gray sandrock,	3'		to	165'	
33.	Gray sandrock,	55'		to	220'	
34.	Dark, hard rock,	12'		to	232'	
35.	Hard, gray SS.,	5'	6"	to	237'	6"
36.	Slate rock, blue,	3'		to	240'	6"
37.	Rock, soft, lighter color,	5'		to	245'	6"
38.	Rock, very hard.	15'	6"	to	261'	
39.	Rock, pale blue, softer,	17'		to	278'	
40.	Rock, pale blue,	—			—	

Butterfield Purchase Well No. 2.

Fig 12. p. 112.



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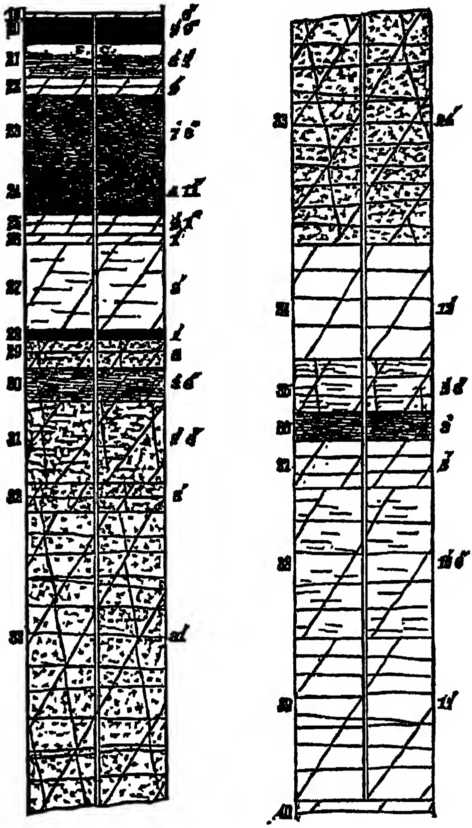


Estimated position of Clermont coal bed.

30 ft.	below	top of	Well	No. 1.
64'	"	"	"	No. 2.
18'	above	"	"	No. 3.
46' 8"	below	"	"	No. 4.
10'	above	"	"	No. 5.

§ *148. Well No. 3 (Fig. 13).*

Estimated elevation of the Clermont coal bed=2275'±. Well mouth above ocean in feet=(919+1338) 2257'.

1. Earth,	5'		to	5'	
2. SS.,	4'		to	9'	
3. Slates and 2 *coal*, } 4. Gray sand rock, }	16		to	25'	
5. Coal slates; 6" of *coal*,	4'		to	29'	
6. Iron ore,	2		to	31'	
7. SS., very fine grained, mixed with fireclay,	3'	6"	to	34'	6"
8. Fine white SS,	3'		to	37'	6"
9. Dark slate,	4'		to	41'	6"
10. Sand rock,	15'	4'	to	56'	10"
11. White sandrock,	30'	2"	to	87'	
12. *Coal*,	2'		to	89'	
13. Dark sandrock,	9'	9"	to	98'	9"
14. Black sandrock,	4'	3"	to	103'	
15. *Coal*,	3'		to	106'	
16. Hard dark rock,	11'		to	117'	
17. *Coal*,	3'		to	120'	
18. Dark rock,	5'		to	125'	
19. White sandrock,	7'	8"	to	132'	8"
20. Gray sandrock,	3'	2"	to	135'	10"
21. Hard blue rock,		2"	to	136'	
22. White SS.,	1'		to	137'	
23. Dark SS.,		8"	to	137'	8"
24. White SS.,	3'	11"	to	141'	7"
25. Iron ore, very hard,		2"	to	141'	9'
26. SS. white and fine,	—			—	

§ *149. Well No. 4 (Fig. 14).*

Estimated elevation of the *Clermont coal bed*=2150. Well mouth above ocean in feet, 2200±.

1. Drift,	4'		to	4'	
2. Slate rock,	15'	6"	to	19'	6"
3. *Coal*,	2'	10"	to	22'	4"
4. Buff SS.,	24'	4"	to	46'	8"
5. *Coal (Clermont bed)*,	3'	1"	to	49'	9"
6. Hard white shale rock,	12'	3"	to	62'	
7. Sandrock,	2'		to	64'	
8. Slate, with small seam of coal,	3'		to	67'	
9. Sandrock,	6'		to	73'	
10. Blue slate,	1'	6"	to	74'	6"
11. White sandrock,	5'	10"	to	80'	4'
12. White sandrock, softer,	2'	8"	to	83'	
13. White sandrock, with fireclay between the layers,	2'	5"	to	85'	5"

Butterfield Purchase Wells No. 3 & 4.

Well No. 3.

Fig. 13. p. 114.

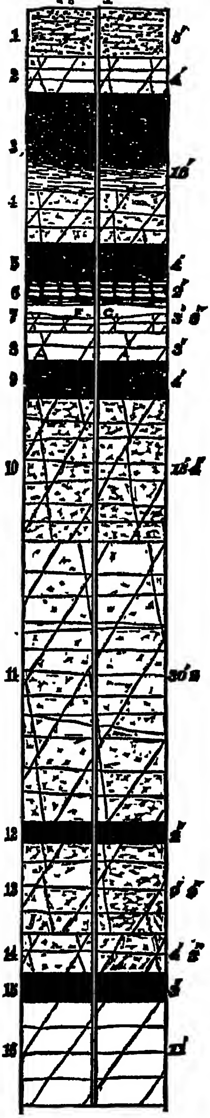
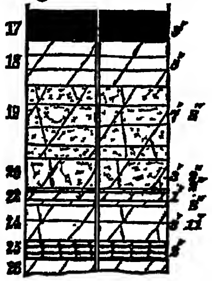


Fig. 13. continued.



Well No. 4.

Fig. 14. p. 114.

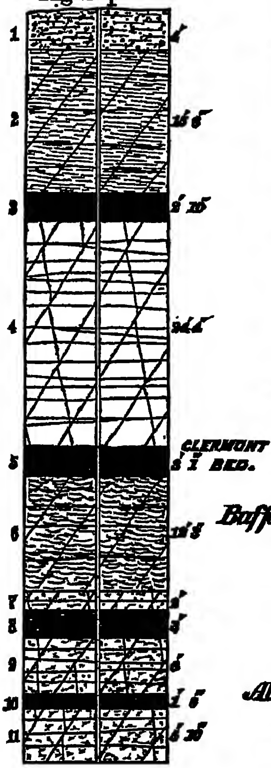


Fig. 14 continued.

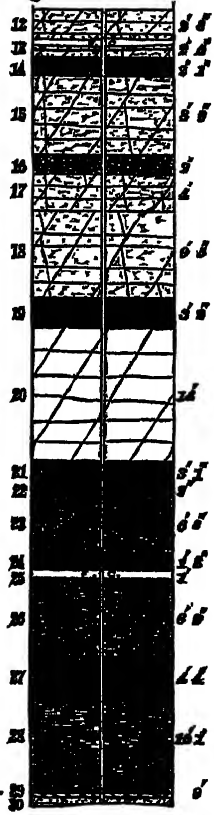
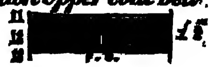


Fig. 15. p. 117.

Buffalo C. C.o's Drill Hole Clermont coal bed.

Fig. 16. p. 118.

Alton Upper coal bed.



14. *Coal,*	2′	1″	to 87′	6″
15. Hard, white sandrock,	8′	6″	to 96′	
16. Blue shale,	2′		to 98′	
17. Very hard white sandrock,	4′		to 102′	
18. Softer white sandrock,	9′	5″	to 111′	5″
19. *Coal,*	3′	2″	to 114′	7″
20. Dark rock,	14′		to 128′	7″
21. *Coal,*	3′	1″	to 131′	8″
22. Sulphur,		2″	to 131′	10″
23. Dark slate,	6′	8″	to 138′	6″
24. *Coal,*	1′	8″	to 140′	2″
25. Fireclay,	1′		to 141′	2″
26. Blue slate,	8′	9″	to 149′	11″
27. *Coal,*	4′	4″	to 154′	3′
28. Blue and black slate,	10′	1″	to 164′	4″
29. Iron ore,	6′		to 164′	10″
30. Gray sandstone,	—		—	

§ *150. Well No. 5 (Fig. 17).*

Estimated elevation of *Clermont coal bed*=2265′. Well mouth above ocean in feet=(917+1338) 2255.

1. Earth,	6′		to 6′	
2. SS.,	6′		to 12′	
3. Iron ore,	2′		to 14′	
4. Thin buff SS., with pebbles,	16′	3″	to 30′	3″
5. Fine grained yellow SS.,	23′	1″	to 53′	4″
6. Hard dark rock,	2′	2″	to 55′	6″
7. Gray slate rock,	8′		to 63′	6″
8. Brown slate rock,	5′	2″	to 68′	8″
9. Gray slate rock,	2′	4′	to 71′	
10 Very hard slate,	3′	2″	to 74′	2″
11. SS.,	1′	2″	to 75′	4″
12. Very hard SS.,	2′	5″	to 77′	9″
13. Light colored SS.,	7′	5″	to 85′	2″
14. Fine and hard gray SS.,	3′	10″	to 89′	
15. Dark SS., thin layers,	2′		to 91′	
16. Light gray SS.,	6′	3″	to 97′	3″
17. Dark sandrock,		10″	to 98′	1″
18. Dark blue coal slates,	1′	4″	to 99′	5″
19. Dark sandrock,	1′	5″	to 100′	10″
20. Fireclay,	2′	2″	to 103′	
21. Black slate, with small seam of coal,		3″	to 103′	3″
22. Gray SS.,	7′	4″	to 110′	7″
23. Dark sandrock,		9″	to 111′	4″
24. Coal shales,	1′	8″	to 113′	
25. Yellow sandrock, containing small particles of coal,		6″	to 113′	6″
26. Dark brown sandrock,	4′	9″	to 118′	3″
27. Dark coal slates and fireclay,	6′	11″	to 125′	2″

28. Slate and *cannel coal*,	6′	6″	to 131′	8″
29. Fireclay,	1′	4″	to 133′	
30. White SS.,		2″	to 133′	2″
31. Dark sandrock,	2′	8″	to 135′	10″
32. Sandrock, lighter and harder,	6′	7″	to 142′	5″
33. Dark SS.,		7″	to 143′	
34. SS., light and hard,	2′	1″	to 145′	1″
35. White SS., fine and hard,	3′	3″	to 148′	4″
36. Dark SS.,		11″	to 149′	3″
37. Coarse, blue slate,	1′	8″	to 150′	11″
38. Dark shale,		1″	to 151′	
39. Dark SS.,	1′		to 152′	
40. Blue slate, with particles of coal,	2′		to 154′	
41. Soft stone and slate,	2′	4″	to 156′	4″
42. SS.,		9″	to 157′	1″
43. Hard SS.,	1′	7″	to 158′	8″
44. White SS., fine and hard,	1′	1″	to 159′	9″
45. Coarser white SS.,	—		—	

§. 151. The Buffalo Coal Company, under the direction of their Superintendent Mr. Graham Macfarlane, drilled a hole in the vicinity of Well No. 4.

The boring was commenced 18′ above the *Clermont coal bed* and the drill was pushed to the depth of 154′ stopping in the center of the OLEAN CONGLOMERATE, passing through successively the JOHNSON RUN SANDSTONE, *Alton coal group*, KINZUA CREEK SANDSTONE and *Marshburg Upper coal bed* which was encountered at a depth of 127′ 6″. About 16′ above the *Marshburg Upper coal bed*, a coal bed was pierced which was 1′ 4″ thick. This coal seems to occur in the body of the KINZUA CREEK SANDSTONE and was found in several other localities in the county.

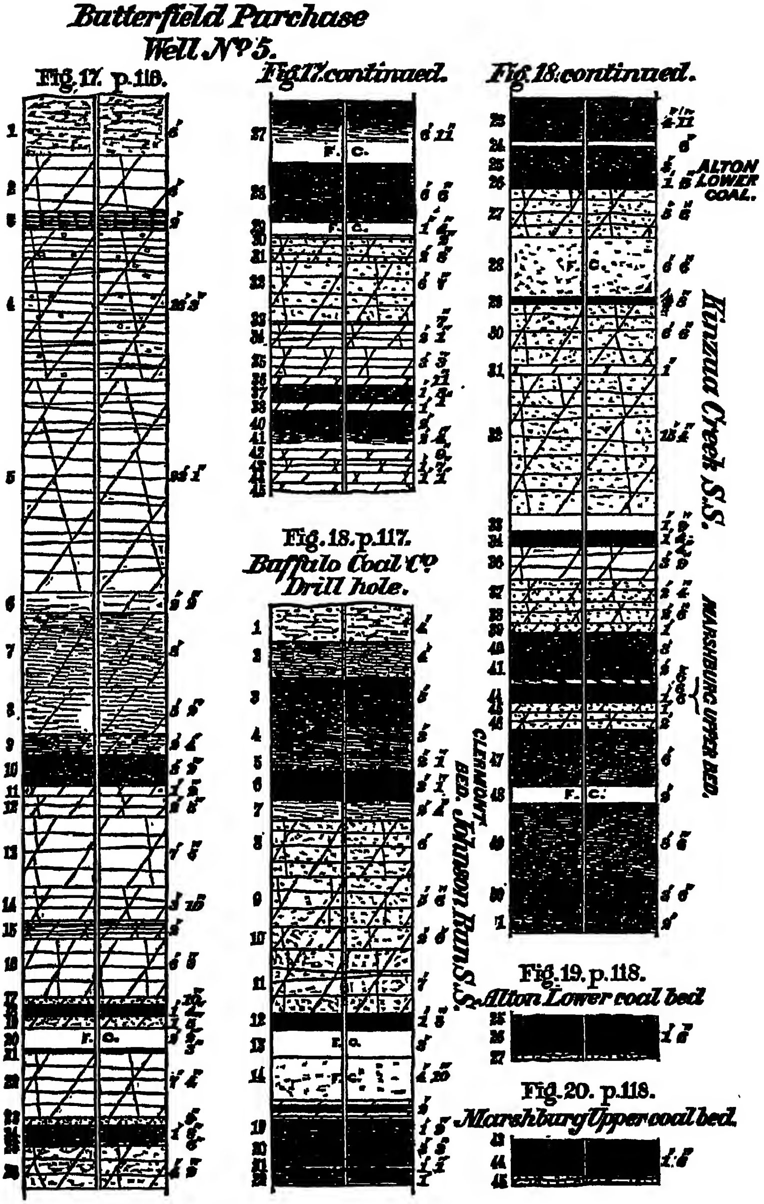
The record of the boring is as follows:

Well drilled by Buffalo Coal Co. in vicinity of Well No. 4. Elevation of Clermont coal bed=2152′; well mouth above ocean in feet=(273+1900) 2173′ (Fig. 18).

1. Drift,	4′		to	4′	
2. Brown sandy slate,	4′		to	8′	
3. Grayish black slate,	5′		to	13′	
4. Black and gray slate,	3′		to	16′	
5. Gray sandy slate,	2′	1″	to	18′	1″
6. *Coal, (Clermont bed)*,	3′	1″	to	21′	2″
7. Fireclay slate,	2′	4″	to	23′	6″
8. Gray sandrock,	6′		to	29′	6″
9. " "	5′	6″	to	35′	
10. Hard sandrock,	2′	6″	to	37′	6″

11.	White gritty sandrock,	7′	to 44′ 6″
12.	*Coal (Alton Upper bed),*	1′ 8″	to 46′ 2″
13.	Fireclay,	3′	to 49′ 2″
14.	Gritty, white fireclay,	4′ 10″	to 54′
15.	Hard, gritty, gray rock,	6″	to 54′ 6″
16.	Hard slate; a little coal,	8″	to 55′ 2″
17.	Hard, gritty, gray rock,	7″	to 55′ 9″
18.	" " " "	3″	to 56′
19.	Blue slate,	1′ 9″	to 57′ 9″
20.	Black slate,	3′ 3″	to 61′
21.	Black slate,	1′ 1″	to 62′ 1″
22.	Very bright black slate,	1′	to 63′ 1″
23.	Black slate,	4′ 11″	to 68′
24.	Sulphur balls,	6″	to 68′ 6″
25.	Black slate,	3′	to 71′ 6″
26.	*Coal and sulphur (Alton Lower bed)*	1′ 6″	to 73′
27.	Fine sandrock,	5′ 6″	to 78′ 6″
28.	White sandy fireclay,	6′ 6″	to 85′
29.	*Coal,*	8″	to 85′ 8″
30.	Hard sandrock,	6′ 6″	to 92′ 2″
31.	Sand rock,	1′	to 93′ 2″
32.	Hard sandrock,	15′ 4″	to 108′ 6″
33.	Break in rock,	1′ 9″	to 110′ 3″
34.	*Coal,*	1′ 4″	to 111′ 7″
35.	Black slate,	4″	to 111′ 11″
36.	Hard gray SS.,	3′ 9″	to 115′ 8″
37.	Dark gray sandrock,	2′ 4″	to 118′
38.	Sandrock,	2′ 6″	to 120′ 6″
39.	Gray sandrock,	1′	to 121′ 6″
40.	Dark gray slate,	3′	to 124′ 6″
41.	Black slate,	2′	to 126′ 6″
42.	Sulphur and slate,	6″	to 127′
43.	Black slate,	6″	to 127′ 6″
44.	*Coal (Marshburg Upper bed),*	1′ 6″	to 129′
45.	Dark gray sandrock,	1′	to 130′
46.	Very hard sandrock,	2′	to 132′
47.	Gray slate,	6′	to 138′
48.	Blue fireclay,	2′	to 140′
49.	Light-gray slate,	8′ 6″	to 148′ 6″
50.	Jet black slate,	3′ 6″	to 152′
51.	Gray slate,	2′	to 154′

§ 152. Several coal openings have been made near the headwaters of Indian run in the southern part of the township. The *Clermont coal* has been opened at an elevation of 2080′, and is reported as being 4′ thick. A second opening was made further north and 20′ lower; this bed was also reported 4′ thick, and is possibly the representative of the *Alton Upper coal.* The top of the ridge near the open-


Butterfield Purchase
Well No 5.
Fig. 17. p. 118.
Fig. 17. continued.
Fig. 18. continued.
F. C.
ALTON LOWER COAL.
Kinzua Creek S.S.
MARSHBURG UPPER BED.
Fig. 18. p. 117.
Buffalo Coal Co
Drill hole.
CLERMONT BED.
Johnson Run S.S.
Fig. 19. p. 118.
Alton Lower coal bed
Fig. 20. p. 118.
Marshburg Upper coal bed.

ings is 2187′ high, and is immediately underlaid by yellow flaggy sandstone.

About 1½ miles north of this opening, a bed 4′ thick (?) was drifted on at the Dennison opening. The elevation of the coal is 2015′. A conglomerate containing small pebbles was found below the opening, and is the representative of the OLEAN, so that the Dennison coal is the *Marshburg Upper bed.*

§ 153. The Sub-conglomerate rocks exposed in the eastern part of the township are 950′ thick (page). At Norwich there are but 480′ exposed as shown in the accompanying section:

No. XII.

OLEAN SANDSTONE AND CONGLOMERATE, ...	50′

Nos. XI and X.

Gray shales and flags with streaks of red shale No. XI and UPPER No. X, ...	40′
Greenish-gray flaggy sandstone, more massive in the upper part and more flaggy in the lower. MIDDLE No. X, (SUB-OLEAN CONGLOMERATE,)	40′
Greenish-gray shales, flags and sandstones stained with iron and bituminous matter. LOWER No. X, ...	220′

No. IX.

Reddish-gray shale, ...	15′
Greenish-gray flaggy sandstone, (Gallup's quarries,)	25′
Red and greenish-gray rotten flaggy sandstone and shale, .	140′
Road level, Norwich cross-roads, ...	1605

§ 154. The OLEAN CONGLOMERATE has the same general features that distinguish it elsewhere in the county.

§ 155. The MAUCH CHUNK No. XI is not sharply defined; it cannot be very thick, as the combined thickness of No. XI and UPPER No. X is only 40′.

§ 156. The SUB-OLEAN CONGLOMERATE is represented by a fine-grained, flaggy sandstone, in which but *very few* and *very small* flat pebbles are found.

The middle member of X contains some finely laminated flagstone strata; but no quarries have been opened. The entire thickness of No. X is about 275′. Between Norwich and Keating this formation becomes very much thicker;

at the latter locality the combined thickness of Nos. XI and X is about 450′.

§ 157. No. IX at Norwich consists, for the most part, of red shale and sandstone containing gray flagstones, which in the upper part are quarried.

§ 158. *Olando Gallup's flagstone quarry*, northwest of Norwich, was opened in the summer of 1877. The quarry is leased and worked by John Digle, of Smethport. The flags are hauled by team to Hamlin station and shipped mostly to Buffalo. They are used extensively for pavements and for the manufacture of highly polished imitation stone. The surface of the flags are smoothed, polished, and treated by a patent process. The face of the quarry when visited was about 10′ high. The upper 8′ are made up of an excellent flagstone; under this there is a foot stratum too poor to quarry, when the flags become good again.

The angle of dip of the cleavage surfaces varies from a perpendicular to 50°. The surfaces are sometimes plane, sometimes warped, but generally have a position at right angles to the dip, which varies from 0° to 2° N. W. The average dip in the quarry is about 1½° N. 75° W. The strata near the outcrop are cracked and fissured along the cleavage planes. Some of the fissures were 8″ wide. There is considerable false bedding in the stone, which invariably makes an angle of 16° with the true bedding.

The size of the flags which are quarried, are as follows: 1½″ flags, 4′, 5′, and 6′ long, 2′ and 3′ wide; 2″ flags, 5′ and 6′ long, 4′ to 6′ wide. Flags as large as 10′×10′ have been gotten out of the quarry.

The flagstone strata occur in the upper part of the Red Catskill, No. IX, as is noticed by the section. They were traced on both sides of the main valley in the vicinity of Norwich, and no doubt other quarries could be opened as fine as those already worked.

§ 159. A test oil well was drilled in the Potato creek coal basin, not far from the Hamlin opening. The hole was drilled to a depth of 2002′. The record was reported to me, but I consider it too unreliable to reproduce here.

§ 160. A number of observations were made in going over

the county road from Norwich to Emporium. It was impossible to place them in a vertical column on account of the strong dips. They are placed in the form of a running section:

Running Section—Norwich to Emporium, Cameron Co.

Bar. elevation.	Description.	Locality.
1605′	Red soil, ...	Norwich Cross-Roads.
1625	" "	J. B. Kimball's.
1625	. . . .	Road crossing, east branch Potato creek.
2145	Coarse-grained gray SS. Loose blocks on hill slopes below, .	Havens Brook Summit.
2115	Gray shaly SS., ...	South of summit.
1987	Slightly red soil, ...	" "
1935	Red shale.	
1890	" "	" "
1720	Red soil, ...	McKean-Cameron county line.
1660	" "	Cameron county.
1635	Gray soil.	
1475	Gray shaly SS.	
1445	Red and gray shales.	
1375	Red soil.	
1290	" "	S. H., N. E. cor. warrant 4999.
1270	Gray flaggy SS., 5′ exposed.	
1225	Gray flaggy SS.	
1200	Red soil.	
1105	" "	
1095	Olive shale and SS., ...	Junction of North creek road and Rich valley road.
1021	. . . .	Emporium Station, P. & E. RR.

It is not the purpose of these running sections, which will be found in a number of places through the report, to show the exact stratigraphical succession of the strata; the observations are too far apart and the dips too indeterminate to permit even an approximate construction. The records will, however, be of value to future explorers.

§ 161. Some of the LOWER POCONO, No. X, strata, are exposed between Wolcott-Comes Summit and Colegrove Station. The elevation of the summit is 2255 feet (bar.), and it is underlaid by 25′ of OLEAN CONGLOMERATE. The position of the strata which were found exposed, is shown in the following section:

OLEAN SANDSTONE and CONGLOMERATE,	25′
Concealed,	248′
SS., gray, gritty and flaggy,	15′
Concealed,	40′
SS., fine-grained, gray, flaggy, and contains fossils,	16′
Olive shales, very much weathered,	10′
Concealed,	46′
SS., greenish, hard and flaggy,	10′

The three lower exposures are possibly in the CATSKILL formation, No. IX; although the horizon separating No. IX and X was not located.

CHAPTER X.

Sergeant Township.

§ 162. Sergeant lies east of Wetmore and Hamlin, south of Hamlin and Keating, and occupies the south central part of the county. Elk county next adjoins it on the south. The extreme southeastern warrant in the township joins Cameron county on the east.

The bulk of the township lies within the Clarion creek basin (page 6). The northeastern part is drained by branches of Potato creek, while the water from a very small area in the southeastern corner flows into the Sinnemahoning creek. The topography is broken and irregular. A greater proportion of Sergeant is underlaid by Carboniferous rocks than any other township; the general level is consequently higher. The greatest height measured, is that of Chapel Hill in the northern part, its elevation being *2310′* above ocean level.

The summit, 1½ miles northeast of Chapel Hill, is possibly still higher. The lowest point is where the West Clarion creek crosses the southern boundary line at an elevation of 1600′.

§ 163. Most of the township lies in the *Clermont* (*Fifth*) *coal basin.* The *Smethport* (*Fifth*) *anticlinal axis* crosses the western part, and the southeastern corner is traversed by the *Norwich* (*Fourth*) *anticlinal axis.* The position of the geological flexures have determined in a great measure the character of the topography.

§ 164. As in the adjoining townships, the general dips in the coal measures have been estimated from a determination of the elevation of the OLEAN CONGLOMERATE. Many of the local dips in the coal beds in the vicinity of Clermont

have been determined by a comparison of the records of the drill-holes bored by the Buffalo Coal Company.

Elevation of the bottom of the Olean conglomerate.

At Chapel Hill,	2300′
Near Well No. 1 (Butterfield purchase),	2100
At Bunker Hill,	2000±
At Seven Mile Summit,	2000±
Near Well No. 4 (Butterfield purchase),	1980
At head of Warner brook,	1980±
At Clermont,	1925
At Wilcox well No. 1,	1900±
At Wilcox well No. 3,	1875
At Williamsville,	1850

At Chapel Hill the OLEAN CONGLOMERATE was found at a greater height than anywhere else in the township. There is a local uplift at this point, for the same stratum to the northeast, in the vicinity of the Haskill well, lies between 200′ and 300′ lower. This irregularity of structure in the southeastern corner of Keating township is due to a break in the *Smethport anticlinal* (page 37). At Williamsville the bottom of the conglomerate is 450′ lower than at Chapel Hill. Along Instanter creek, in the center of the basin northeast of Williamsville, the conglomerate lies at an elevation of 1950′; 100′ higher than at Williamsville, 25′ higher than at Clermont. But, we would expect to find the conglomerate at Williamsville, which lies directly over the *Kinzua-Emporium anticlinal*, higher than to the northeast. In point of fact the *Kinzua-Emporium anticlinal* has not raised the measures at Williamsville to a greater topographical height than to the northeast, but has very much diminished the dip of the rocks in the center of the basin to the southwest. The flexure at this point is really a monoclinal.* To the southwest, toward Gen'l Kane's limestone quarry, the dip is very much greater than it is to the northeast. From Wilcox well No. 1 to Williamsville the average rate of dip per mile is *nil.* The Wilcox wells are very near the *Smethport axis*, while Williamsville is in the center of the basin. The fact that the OLEAN CONGLOMER-

*Monoclinal is applied to strata that dip in one direction, and which do not apparently form sides of ascertained anticlines or synclines.

ATE at each point is at about the same elevation seems paradoxical; when we take into consideration the position of the *Kinzua-Emporium anticlinal* the explanation readily suggests itself.

§ 165. The following table of dips has been estimated from the elevations given above:

Dips estimated for the OLEAN CONGLOMERATE.

FROM	TO	Distance in miles	Direction.	Average rate of dip per mile.
Chapel Hill, ...	Bunker Hill, ...	$2\frac{1}{8}$	S. $16\frac{1}{2}$° E.	104′
Bunker Hill, ...	Clermont, ...	$1\frac{7}{8}$	S. 41° W.	40′
Warner brook, . . .	"	$1\frac{3}{4}$	S. $67\frac{1}{2}$° E.	32′
Clermont, ...	Williamsville, ...	$6\frac{1}{8}$	S. $46\frac{1}{2}$° W.	12′
Seven mile Summit, .	"	$4\frac{1}{8}$	S. $46\frac{1}{2}$° E.	88′
Well No. 1,*	Well No. 4,*	$1\frac{1}{4}$	N. $82\frac{1}{4}$° W.	96′
Well No. 4, . . .	Clermont, ...	$1\frac{5}{8}$	N. 46° W.	34′
Wilcox Well, No. 1, . .	Williamsville, ...	$5\frac{3}{4}$	S. $83\frac{1}{2}$° E.	00′±

* Wells on the Butterfield purchase.

The magnetic bearings are estimated from the meridian of 1793 and 1794.

The position of the bottom of the OLEAN CONGLOMERATE at Chapel Hill and Bunker Hill was determined at the road crossing.

It will be noticed that from Bunker Hill to Clermont, in the center of the basin, the average dip is 40′ per mile; on the same line from Clermont to Williamsville it is 12′ per mile, while from the latter place to Kane's limestone quarry it is about 125′ per mile.

The north-west and south-east dips, on either side of the basin, vary from 32′ to 104′ per mile.

§ 166. The total thickness of strata exposed above water level in the township, is about 710′, sub-grouped as follows:

COAL MEASURES, (including the conglomerate No. XII,)	285′
MAUCH CHUNK No. XI, } POCONO No. X, ... }	325′
RED CATSKILL No. IX, ...	100′±
Total, ...	710′

The highest stratum (gray slate above *Dagus coal bed*,) is found on the summit half a mile south of the Buffalo Coal Company's mine No 1, at an elevation of 2240′. The lowest stratum is found on Long run in the northern part of the township, west of Chapel Hill; the elevation is unknown.

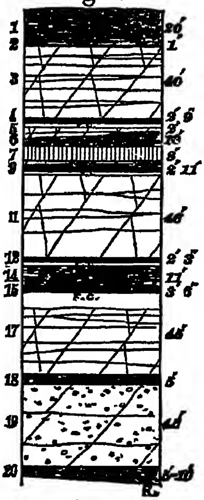
The record of Wilcox well No. 2, would extend the section downward 1800′ further, so that we have accurate knowledge of 2500′ of *Carboniferous* and *Devonian* rocks in Sergeant.

The members of the *Carboniferous* formation have been minutely defined by the explorations of the Buffalo Coal Company.

A generalized section of the coal measures in the vicinity of Clermont has been compiled from the records of drill holes Nos. 1 and 9, (see section plate No. II.) The details are as follows:

1.	Gray and black slate,	20′	
2.	*Coal*,	1′	
3.	Hard fine-grained gray and brown sandstone,	40′	
4.	*Dagus coal*,	2′	9″
5.	Fireclay,	2′	
6.	Sandstone and slate,	10′	
7.	*Clermont limestone*,	8′	
8.	Sandstone and slate,	31′	6″
9.	*Clermont coal*,	2′	11″
10.	Fireclay,	2′	
11.	JOHNSON RUN SANDSTONE,	46′	
12.	*Alton Upper coal*,	2′	8″
13.	Fireclay,	2′	6″
14.	Blue and black slate,	11′	
15.	*Alton Lower coal*,	3′	6″
16.	Fireclay,	—	—
17.	KINZUA CREEK SANDSTONE,	45′	
18.	*Marshburg Upper coal* and slate,	5′	
19.	OLEAN CONGLOMERATE,	45′	
20.	Black slate, (*Marshburg Lower coal*,)	5′ to 10	

Fig. 21.



The slate at the top of the section is the same as that immediately underlying Pistner Hill, in the *Johnson run basin* east of Wilcox and the St. Mary's Hill, both in Elk county. The foot coal,* which occurs under this slate and

* Middle Kittanning coal bed.

40′ above the *Dagus coal,* (drill hole No. 1,) is also found in these two hills.

§ 167. In the *Clermont basin* the top rock of the *Dagus coal* is a hard fine-grained gray and brown sandstone. The character of the strata occupying the interval between these two coals is variable. It is generally filled by alternating gray and black slate and sandy shales; seldom being sandstone as found in drill hole No. 1.

§ 168. The *Dagus coal bed* has been found only in the knoll lying between the headwaters of Red Mill brook, Beaver run, and Instanter creek. The area underlaid by this bed is between 40 and 50 acres. In drill hole No. 1 the coal was struck at a depth of 61′, and was found to be 2′ 9″ thick, underlaid by a two foot bed of fireclay.

In this knoll the coal is but 12′ above what was noted by the drillers as a gray slate or *bastard limestone* (*Clermont limestone*). No where in McKean or Elk county does the *Dagus coal* lie in such close proxmity to the limestone as here.

§ 169. *The Clermont* (*Ferriferous*) *limestone* was first studied, and its true position in the coal measures determined in the vicinity of Clermont. I gave it this geographical name until its identity with the *Ferriferous limestone* should have been absolutely determined (page 46). The limestone outcrops on the Wilcox farm between Clermont and Warner brook. It consists of a bluish gray silicious limestone 6′± thick and has been stripped on this farm for a number of years. The lime being used both for building and agricultural purposes. In drill hole No. 1 the limestone was pierced and reported 8′ thick. An outcrop of the bed was found in several places near the headwaters of Instanter creek and County Line run. In every case the limestone was found to be very silicious and of *poor* quality. With the railroad facilities in McKean county it is hardly probable that the limestone can ever be economically worked. The over rock of the *Clermont coal* in Sergeant consists principally of gray and blue slate alternating with white sandstone. Its thickness ranges from 25′ to 35′.

§ 170. The *Clermont coal bed,* in the township, up to this

time has proved to be one of the most important beds in the county. Its thickness varies from 2′ 4″ to 3′ 6″, with a possible average of 3′. The coal is generally compact and brittle, has a deep black luster, and carries numerous thin partings of mineral charcoal and iron pyrites.

On analysis it showed (A. S. McCreath):

Water @ 225°,	1.470
Volatile matter,	38.710
Fixed carbon,	44.561
Sulphur,	4.839
Ash,	10.420
	100.000
Coke, per cent.,	59.820
Color of ash,	pink.
Fuel ratio,	1:1.15

A better idea of the character of the coal bed can be formed from the detailed description of the openings and drill holes.

The fireclay immediately under the coal is white and of a homogeneous character. Some of the clay has been shipped to Buffalo and is said to make a fair fire brick. It is from 2′ to 3′ thick.

§ 171. The JOHNSON RUN SANDSTONE consists of a hard white and yellow sandstone more or less stained with iron. In places it contains alternating shale and slate strata and is from 45′ to 50′ thick. Blocks of the sandstone may be seen in the vicinity of the school house back of the Clermont railroad station. More than half the area of the flats and summits in Sergeant are immediately underlaid by this rock.

§ 172. The average thickness of the *Alton group* is 20′. Judging from the drill holes which have pierced it, it has a variable character and the individual strata are subject to sudden changes. It contains but two coal beds which are separated by black and blue slate or fireclay. The *Alton Upper coal* is generally a one bench coal from 3′ to 3′ 6″ thick. The bed has recently been opened and mined by the Buffalo Coal Company on the east side of the Instanter creek (see page 132). It was encountered in drill holes Nos.

2, 3 and 9. Drill holes Nos. 4 and 8 passed through the horizon of the bed but no coal was found.

The *Alton Lower coal* is *generally* made up of two distinct benches of coal separated by from 2″ to 8″ of slate. The entire thickness of the bed ranges from 2′ 6″ to 4′, more or less. The coal is shown in section in drill holes Nos. 4, 8 and 9. It has never been mined in the township. No coal bed was found that might represent the *Alton Middle coal.*

§ 173. The KINZUA CREEK SANDSTONE has the same general character as observed elsewhere in the county. Its thickness is 45′.

§ 174. The *Marshburg Upper coal* and associated slates have a thickness of 5′ to 10′. The bed has been opened in a number of localities. It is too thin and too impure to be profitably mined. On the Martin farm considerable coal was mined a number of years ago and used for blacksmithing. It was said to produce a strong fuel but very sulphurous and high in ash. Its thickness is 2′ to 2′ 6″.

§ 175. The OLEAN CONGLOMERATE varies but little in character from that observed elsewhere. It seems however to contain fewer and smaller pebbles. Its thickness is 45′. Immediately under the conglomerate occurs 5′ to 10′ of black slate; in some places very cannelly as on the Boyer farm; in other places it contains a thin coal bed. This is the representative of the *Marshburg Lower coal bed.* We are perfectly safe in saying, that a workable and profitable coal will never be found at this geologic horizon (see page 64).

§ 176. The Buffalo Coal Company's tract (Plate No. II) lies in the center of the *Clermont* (*Fifth bituminous*) *coal basin.* The axis of the basin at Clermont passes between the railroad station and the school house back of the company's store. Its direction is N. 47° E. The average dip on the eastern side of the basin from Well No. 4 (Butterfield purchase) to Clermont is at the rate of 34′ per mile. On the western side of the basin, from Warner brook to Clermont, the average rate of dip per mile is 32′.

The average rate of dip per 100′ of the *Clermont coal bed* has been determined from a comparison of the records of

the drill holes. The following table shows the elevation of the coal at each drill hole, the distance between the location of the holes and the direction and average rate of dip:

Elevation and dip of the Clermont coal bed on the Buffalo Coal Company's tract.

Locality.	Elevation of Clermont coal.	Locality.	Elevation of Clermont coal.	Direction.†	Distance in feet.†	Average dip per 100 feet.
Mine No. 1,	189·*	Drill No. 9,	200'*	S. 2° 30' E.	1675	.66'
Drill No. 9,	200'	" 1,	215'	S. 12° 00' E.	1540	.97'
" 1,	215'	" 6,	242'	N. 87° 45' E.	2650	1.02'
" 1,	215'	" 5,	253'	S. 57° 30' E.	1600	2.38'
" 5,	253'	" 7,	269'	S. 56° 15' E.	1175	1.36'
" 1,	215'	" 8,	246'	S. 22° 00' W.	1680	1.84'
" 8,	246'	" 4,	261'	S. 89° 30' W.	940	1.5
" 10,	245' to 250'	" 11,	—	S. 1° 30' E.	1000	—

*Add 1900' to reduce to the corrected datum of the McK. and B. RR.

† The direction and distances have been determined by measurements taken directly from the map, they are therefore only approximate.

§ 177. The rocks have a preceptible thickening in certain directions, and we can only speak of the precise dip of individual strata. Even here a difficulty besets us, for the strata are locally warped in many cases to such an extent, as to produce reverse dips, forming *lumps* in the mines: The computed dips in the table and placed on the map, (Plate II,) are the average dips between the two points indicated; there may occur local reverse dips between the same points.

The dip of the coal is so slight, that it has only been through the most careful mine management that pumps have not been introduced.

§ 178. Two beds have been worked by the Buffalo Coal Company, the *Clermont* and *Alton Upper* coals.

The *Clermont bed* has been worked at the company's mines directly opposite the railroad at Clermont. The coal, where struck, was 2' 6" thick, with bone parting of 1" about 8" from the top. As the work was extended under greater

cover the bed increased to 2′ 9″, and in drill hole No. 1, immediately south of the mine mouth, it was found 3′ 6″ thick. The following section represents an average of the coal in this basin. (Fig. 26).

Hard blue and gray slate,	2′		to	3′
Coal,				8″
Bone,		1½″	to	1″
Coal,	2′	3″		
White fireclay,	2′		to	3′

The over slate is hard and firm, and makes a good roof.

The thickness of the coal in the several drill holes is shown on the accompanying plates of sections. No disturbance or faults have been found in this bed other than local rolls and horse-backs.

The *Alton Upper coal* is being worked in the company's new mine on the east side of Instanter creek.

The average section of the bed is as follows : (Fig. 27).

Hard gray slate,	4′±			
Coal,	3′	4″		
Fireclay,	2′		to	3″

§ *179. Drill hole No. 1 (Fig. 22).*

Top of drill hole above ocean in feet=(1900′+334′) 2234′.

1.	Gray slate,	14′	to 14′	
2.	Black slate,	6′	to 20′	
3.	*Coal,*	1′	to 21′	
4.	Hard, fine, brown and gray rock, (SS.,)	40′	to 61′	
5.	*Coal, (Dagus bed,)*	2′ 9″	to 63′	9″
6.	Fire clay, white,	2′	to 65′	9″
7.	Brown sand rock, fine,	8′	to 73′	9″
8.	Black slate,	2′	to 75′	9″
9.	Gray slate and bastard limestone, (*Clermont limestone,*)	8′	to 83′	9″
10.	Hard, gray rock,	9′	to 92′	9″
11.	White bastered rock,	5′	to 97′	9″
12.	Black slate,	4′	to 101′	9″
13.	White sand rock,	3′	to 104′	9″
14.	Gray slate,	10′ 6″	to 115′	3″
15.	Coal, (*Clermont bed,*)	3′ 6″	to 118′	9″
16.	Gray fire clay rock,	—	—	

This drill hole goes through the highest coal measures in the basin, and is the only one that shows the "*foot coal*" above the *Dagus bed.*

§ *180. Drill hole No. 2 (Fig. 23).*

Top of drill hole above ocean in feet=2140', (about.)

1. Soft clay,	3'	to	3'	
2. *Coal*,	2' 4"	to	5'	4"
3. Brown rock,	20'	to	25'	4"
4. *Coal, (Clermont bed,)*	4'	to	29'	4"
5. White fire clay,	9'	to	38'	4"
6. Hard flinty rock, (limestone,)	5'	to	43'	4"
7. White rock, (SS.,)	33'	to	76'	4"
8. Black slate,	4'	to	80'	4"
9. *Coal, (Alton Upper bed,)*	2' 1½"	to	82'	5½"
10. Black slate,	4' 5"	to	86'	10½"
11. *Coal*, (thickness uncertain,)	—		—	
12. Gray fire clay,	—		—	

Coal (stratum No. 2.) is too near the *Clermont bed* to be the representative of the *Dagus bed*, as it occurs immediately under a clay soil, it is probably an outcrop far below the true position of the bed from which it has come. The location of this drill hole is between No. 3 and John Heitman's house on the Wilcox-Clermont road, between Cold Spring run and Instanter creek.

§ *181. Drill hole No. 3 (Fig. 31).*

Top of drill hole above ocean, in feet=2115' (about).

1. Soft clay,	2	to	2
2. Wash coal, (crop Clermont bed),	1	to	3
3. White fireclay,	2'	to	5'
4. Limestone, (?)	5'	to	10'
5. Mixed fireclay slate and shales,	24'	to	34'
6. Brown SS.,	20'	to	54'
7. Black slate,	3'	to	57'
8. *Coal (Alton upper bed),*	4'	to	61'
9. Gray slate,	—		—

The exact location of this drill hole is not known; it is on the ridge between John Heitman's house and what is known as the "five foot" coal opening on the west side of Instanter creek, (see map, Plate II). The coal bed, (4') in which drilling was stopped, is the representative of the "five foot" bed.

§ *182. Drill hole No. 4 (Fig. 35).*

Top of drill hole above ocean, in feet=(1900+322) 2222'.

1. White rock and slate,	60'	to	60'
2. *Coal, (Clermont bed),*	1'±	to	61'

3. White fireclay,	3′	to 64′
4. Hard white sandrock,	59′	to 123′
5. Blue slate, with streaks of sandstone,	11′	to 134′
6. Black slate,	8′	to 142′
7. *Coal* (*Alton lower bed* (?),	3′ 8″	to 145′ 8″
8. Fireclay,	3′ 10″	to 149′ 6″

The hole is located in the center of the projected town of Instanter. The driller is said to have been intoxicated while the greater portion of the hole was being drilled, so that the details of the record are not considered to be altogether reliable. The *Alton upper coal bed* is absent from the section. The coal of stratum No. 7 is shown as one solid bench of coal; if it is the representative of one of the *Alton lower beds*, either middle or lower, as we have supposed, it is probably composed of two or more distinct benches of coal, separated by slate or fireclay.

§ *183. Drill hole No. 5* (*Fig. 36*).

Top of drill hole above ocean, in feet=(1900+320) 2220′.

1. Drift,	9′ 6″	to 9′ 6″
2. Blue slate rock,	18′ 6″	to 28′
3. Black slate,	3′	to 31′
4. Bony Slate,	1′	to 32′
5. Blue slate, with hard streaks,	32′	to 64′
6. *Coal* (*Clermont bed*),	2′ 10″	to 66′ 10″
7. Fireclay,	8″	to 67′ 6″

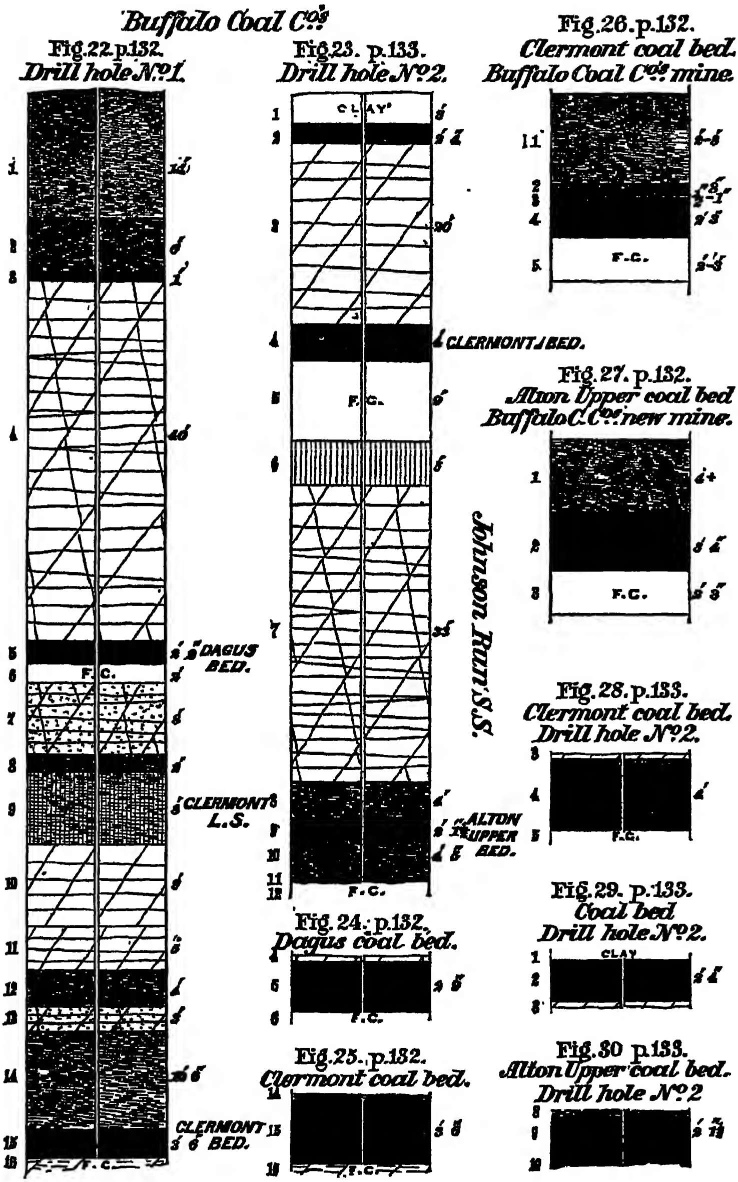
This drill hole goes through the geologic horizon of the *Clermont limestone* and stops in the under clay of the *Clermont coal.* The limestone no doubt occurs here, was drilled through, but not noticed by the drillers. Its place would be in the interval of *blue slate rock* (stratum No. 2).

§ *184. Drill hole No. 6* (*Fig. 41*).

Top of drill hole above ocean, in feet=(1900+271) 2171′.

1. Drift,	5′	to 5′
2. Blue slate,	12′ 6″	to 17′ 6″
3. Black slate,	1′ 6″	to 19′
4. Blue slate,	6″	to 19′ 6″
5. Very black slate,	6″	to 20′
6. Gritty blue slate,	7′ 3″	to 27′ 3″
7. *Coal,* (*Clermont bed,*)	2′ 6″	to 29′ 9″
8. Sandy fireclay,	1′	to 30′ 9″

This drill hole is located nearer the outcrop of the *Cler-*


Buffalo Coal Co's
Fig. 22. p. 132.
Drill hole No. 1.
Fig. 23. p. 133.
Drill hole No. 2.
Fig. 26. p. 132.
Clermont coal bed.
Buffalo Coal Co's mine.
CLAY
F. C.
CLERMONT BED.
Fig. 27. p. 132.
Alton Upper coal bed
Buffalo C. Co's new mine.
DAGUS BED.
CLERMONT L.S.
Johnson Run S.S.
Fig. 28. p. 133.
Clermont coal bed.
Drill hole No. 2.
ALTON UPPER BED.
Fig. 24. p. 132.
Dagus coal bed.
Fig. 29. p. 133.
Coal bed
Drill hole No. 2.
Fig. 25. p. 132.
Clermont coal bed.
Fig. 30 p. 133.
Alton Upper coal bed.
Drill hole No. 2
CLERMONT BED.

mont coal bed than any hole drilled by the Buffalo Coal Company.

§ *185. Drill hole No. 7* (*Fig. 38*).

Top of drill hole above ocean, in feet=(.900+315) 2215′.

1.	Drift,	8′ 6″	to 8′ 6″
2.	Brown rock,	6′	to 14′ 6″
3.	*Coal,*	2′	to 16′ 6″
4.	Clayey blue slate,	3′	to 19′ 6″
5.	Soft slate,	23′ 6″	to 43′
6.	*Coal, (Clermont bed,)*	2′ 4″	to 45′ 4″
7.	Blue fireclay,	2′	to 47′ 4″
8.	Gritty hard clay,	2′	to 49′ 4″
9.	White and gray hard rock,	34′	to 83′ 4″
10.	*Coal, (Alton Upper bed,)*	1′ 8″	to 85′
11.	Fireclay,	1′	to 86′

Coal bed (stratum No. 3,) near the top of the section may possibly be the representative of the coal which is frequently formed under the *Clermont* (*Ferriferous*) *limestone.* It is not sufficiently high in the coal series to be the *Dagus bed.*

§ *186. Drill hole No. 8* (*Fig. 42*).

Top of drill hole above ocean, in feet=(1900+314) 2214′.

1.	Drift,	15′ 10″	to 15′ 10″
2.	Soft white sandrock,	5′	to 20′ 10″
3.	Gritty black slate,	14′ 2″	to 35′
4.	Gray sandrock,	11′	to 46′
5.	Blue slate rock,	10′	to 56′
6.	Gray sandrock,	2′ 6″	to 58′ 6″
7.	Blue slate,	6′ 6″	to 65′
8.	Gray slate,	1′	to 66′
9.	Blue slate,	1′	to 67′
10.	*Coal, (Clermont bed,)*	2′ 6″	to 69′ 6″
11.	Blue fireclay,	3′	to 72′ 6″
12.	Hard, white sandrock,	39′ 6″	to 112′
13.	Light gray sandrock,	7′	to 119′
14.	White sandrock,	15′	to 134′
15.	Blue slate,	11′	to 145′
16.	Black slate,	3′ 10″	to 148′ 10″
17.	*Coal, (Alton Lower bed,)*	3′ 5″	to 152′ 3″
18.	Fireclay,	3′ 1″	to 155′ 4″
19.	Gray sandrock,	6′	to 161′ 4″

The *Alton Upper coal bed* was not found in this drill hole. It has possibly been cut out by the *white sandrock* of stratum

Buffalo Coal Co.

Fig. 31. p. 133.
Drill hole No 3.

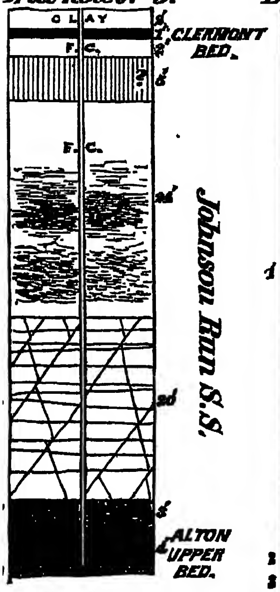


Fig. 35. p. 133.
Drill hole No 4.

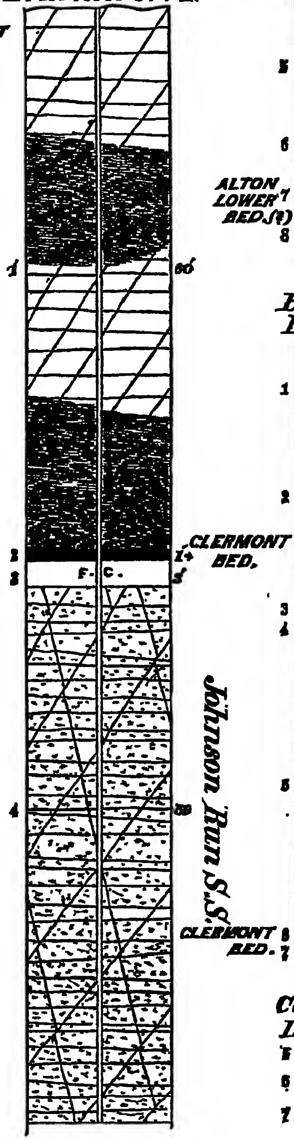


Fig. 35. continued.

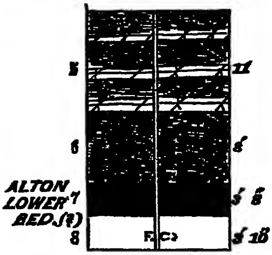


Fig. 32. p. 133.
lton Upper coal bed.
Drill hole No 3.

Fig. 33. p. 133.
lermont coal bed.
Drill hole No 4.

Fig. 34. p. 134.
lton Lower coal bed.
Drill hole No 4.

Fig. 36. p. 134.
Buffalo Coal Co.
Drill hole No 5.

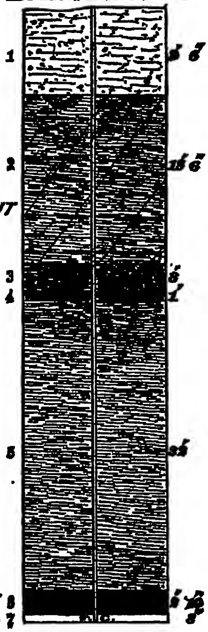
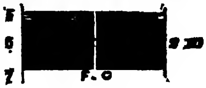


Fig. 37. p. 134.
Clermont coal bed.
Drill hole No 5.



No. 14. Coal No. 17 is either the representative of the *Alton Middle or Lower bed.*

§ *187. Drill hole No. 9 (Fig. 45).*

Top of drill hole above ocean in feet=(1900'+254') 2154'.

1.	Loose, sandy shale,		10'	to 10'
2.	Bony slate,		8''	to 10' 8''
3.	Hard gray slate,		34'	to 44' 8''
4.	Sandstone,		2'	to 46' 8''
5.	Gray slate,		2'	to 48' 8''
6.	*Coal (Clermont bed)*,		2' 11''	to 51' 7''
7.	Gray sandrock,		11'	to 62' 7''
8.	White sandrock,		30' 6''	to 93' 1''
9.	Pebbly sandrock, containing streaks of coal,		4' 6''	to 97' 7''
10.	"Crevice,"		6''	to 98' 1''
11.	*Coal (Alton Upper bed)*,		2' 8''	to 100' 4''
12.	Sandy clay-slate,		2' 6''	to 102' 10''
13.	Slate,		7'	to 109' 10''
14.	Blue slate,		4' 3''	to 114' 1''
15.	*Coal* (bony),	*Alton Middle, or Lower bed,*	4''	to 114' 5''
16.	*Coal*,		8''	to 115' 1''
17.	Black slate,		1'	to 116' 1''
18	*Coal*,		1' 6''	to 117' 7''
19.	Black slate,		1'	to 118' 7''
20.	Gray sandrock,		5'	to 123' 7''

This drill hole gives us the most exact knowledge of the strata for about 125' above the KINZUA CREEK SANDSTONE.

§ *188. Drill hole No. 10 (Fig. 46).*

Top of drill-hole above ocean in feet=(1900'+226') 2126'.

1.	Drift and undescribed interval,	47'	to 47'
2.	*Coal (Alton Upper bed)*,	3' 9''	to 50' 9''

The drill hole is located immediately over the mouth of the company's new mine.

§ *189. Drill hole No. 11 (Fig. 51).*

Top of drill hole above ocean in feet =(1900+237) 2137'.

1.	Drift,	9' 8''	to 9' 8''
2.	Brown SS.,	34'	to 43' 8''
3.	Blue slate,	3'	to 46' 8''
4.	Black slate and bony coal,	3''	to 46' 11''
5.	Black slate,	2' 6''	to 49' 5''
6.	Gray sandy slate,	4' 10''	to 54' 3''
7.	Dark blue slate,	1'	to 55' 3''
8.	Gray sandy slate,	4' 0½''	to 59 3½''
9.	*Coal (Alton Upper bed)*,	3' 8''	to 62 11½''
10.	Fire clay,	—	—

Buffalo Coal Co's

Fig. 38. p. 136.
Drill hole No. 7.

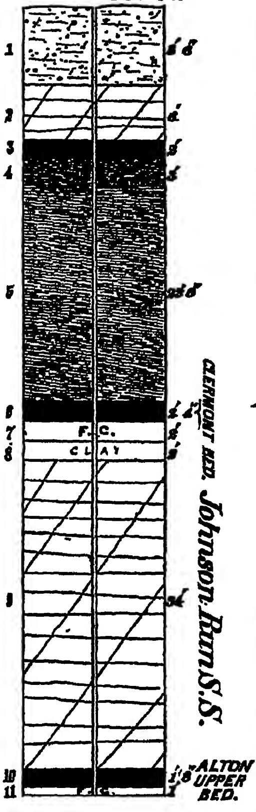


Fig. 41. p. 134.
Drill hole No. 6.

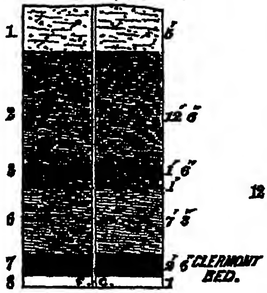


Fig. 42. p. 133.
Buffalo Coal Co's
Drill hole No. 8.

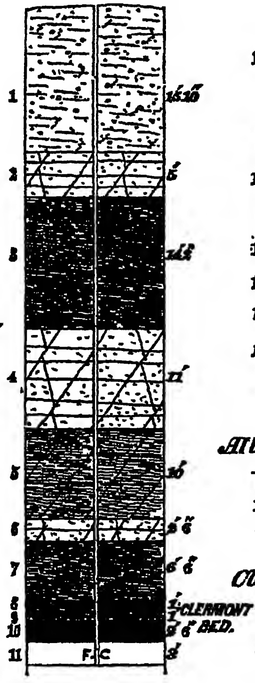


Fig. 42. continued.

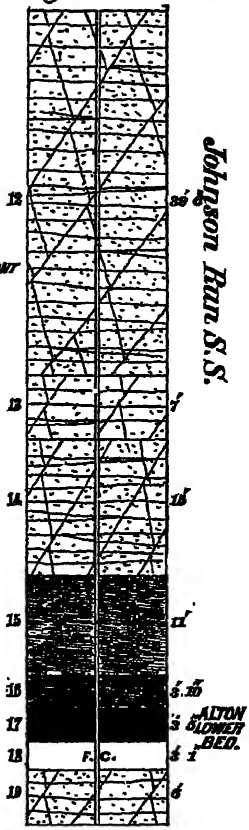


Fig. 39. p. 136.
Clermont coal bed.
Drill hole No. 7.

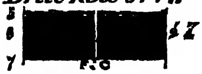


Fig. 40. p. 136
Alton Lower coal bed.
Drill hole No. 8.

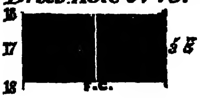


Fig. 43. p. 136.
Alton Upper coal bed.
Drill hole No. 7.

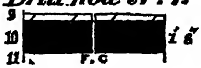
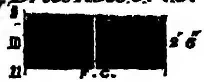


Fig. 44. p. 136.
Clermont coal bed.
Drill hole No. 8.



This hole was drilled near the company's new mine. The strata pierced above the coal bed are the representatives of the JOHNSON RUN SANDSTONE. The coal at the bottom of the section is the same coal that is opened in the mine.

§ 190. The following section was constructed on the Martin and Backus farms, on the headwaters of Red Mill brook, in the vicinity of Bunker hill: (Fig. 55):

1.	Concealed interval,		50′
2.	*Coal*,	(*Alton Upper bed*,)	2′
3.	Fire clay,	(*Alton Upper bed*,)	6″
4.	*Coal*,	(*Alton Upper bed*,)	3′ (?)
5.	Fire clay,	(*Alton Upper bed*,)	6″
6.	*Coal*,	(*Alton Upper bed*,)	2′
7.	Concealed interval,		30′±
8.	*Coal*,	(*Alton Lower bed*,)	2′
9.	Coaly slate,	(*Alton Lower bed*,)	3′
10.	Cannelly slate,	(*Alton Lower bed*,)	1′ 6″
11.	KINZUA CREEK SANDSTONE,		50′
12.	Iron ore,		5′ (12–14)
13.	*Coal* (*Marshburg Upper bed*,)		
14.	Fire clay,		
15.	OLEAN CONGLOMERATE,		45′
16.	Cannel slate,		—

The *Alton Upper bed* was opened in the summer of 1876 at what is known as the Backus opening. The section of the bed was reported by Mr. Seth Backus of Smethport. The total thickness of coal is 7′, which is an *excessive one* for this bed.

The *Alton upper bed* has been opened and mined near the head of the north fork of Boyer brook, a branch of Red mill brook.

The *Marshburg upper bed* has been opened on the Adam Martin farm. The opening was made about 1860, and coal is said to have been mined and hauled as far as Olean. After the war, in one winter Mr. Martin shipped 400 tons from this opening to Millgrove, Cuba and Hindsdale, New York. It was necessary to open the bed on the dip; so that the coal was only mined along the outcrop. The average thickness of the bed was about 2′. The coal was hard, slaty, and made a poor fuel.

The black cannel slate under the OLEAN CONGLOMERATE

Buffalo Coal Company's

Fig. 45. p. 138.
Drill hole No 9.

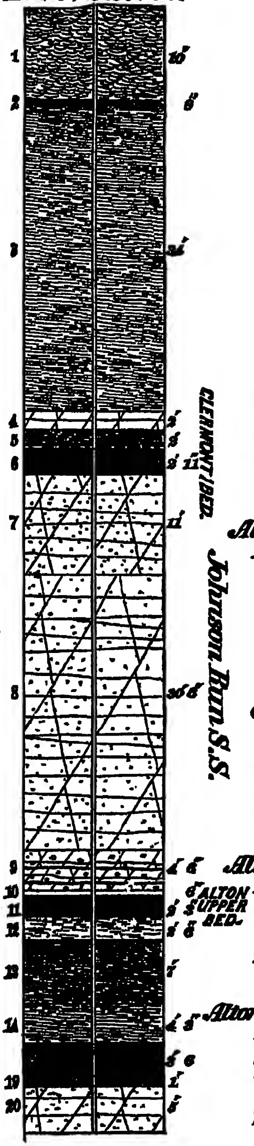


Fig. 46. p. 138.
Drill hole No 10.

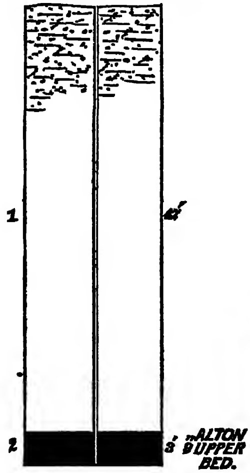


Fig. 47. p. 138.
Alton Upper coal bed.
Drill hole No 10.

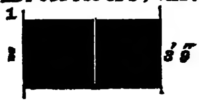


Fig. 48. p. 138.
Clermont coal bed.
Drill hole No 9.

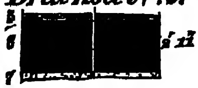


Fig. 49. p. 138.
Alton Upper coal bed.
Drill hole No 9.

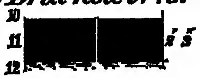


Fig. 50. p. 138.
Alton Middle or Lower coal.
Drill hole No 9.

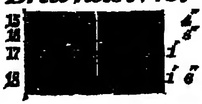


Fig. 51. p. 138.
Drill hole No 11.

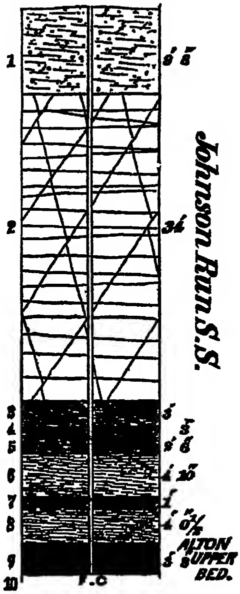


Fig. 52. p. 138.
Alton Upper coal bed.
Drill hole No 11.

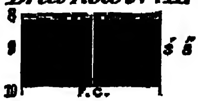


Fig. 53. p. 13
Clermont coal bed.
Drill hole No 6.

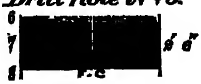
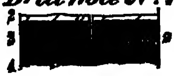


Fig. 54. p. 138.
Coal bed.
Drill hole No 7.



has been opened on the Backus farm and along the Clermont-Hamlin road on the Boyer farm.

§ 191. In ascending the hill to the east of Wernwag station the following section was constructed: (Fig. 64):

1.	Slate and sandstone,	15′±
2.	*Coal (Alton upper bed)*,	2′
3.	White fireclay,	5′
4.	Gray argillaceous shale, stained with iron,	6′
5.	Black and gray slate, containing scattered carbonate of iron balls,	5′
6.	Black cannelly slate (*coal outcrop*),	12′
7.	Fireclay,	5′(?)
8.	KINZUA CREEK SANDSTONE,	45′
9.	*Marshburg coal interval*,	5′±
10.	OLEAN CONGLOMERATE,	45′
11.	Black slate,	—
12.	UPPER POCONO, No. X,	50′±
13.	SUB-OLEAN SANDSTONE, exposed in railroad cut below Wernwag station.	

The *Alton upper coal bed* has been worked at the Herzog opening, on the Buffalo Coal Co.'s tract. The *Alton lower bed* has not been opened, but the outcrop noted in stratum No. 6 is doubtless from this bed.

§ 192. In the western part of warrant 2988, directly east of the township line, on the summit between Long brook and Warner brook, the *Clermont coal bed* (?) has been opened at the Deer Lick opening; the elevation of the opening is 2150′±, and a section of the bed was reported, (Fig. 60):

1.	Slate,	—
2.	Coal,	3′ 2″
3.	Clay and shale,	1′ 6″
4.	Coal,	1′ 6″
5.	Fireclay,	—

Mr. Seth Backus reports that a drill hole was bored in the vicinity of the opening and some 30′ to 40′ vertically below it. The opening is in Sergeant and the drill hole in Hamlin township.

The following section is compiled from the record of the drill hole and surface observations. (Fig. 59):

1.	Slate,	—
2.	Coal,	3′ 2″
3.	Clay and shale,	1′ 6″

Martin & Backus Farms Section.

Fig. 55. p. 140.

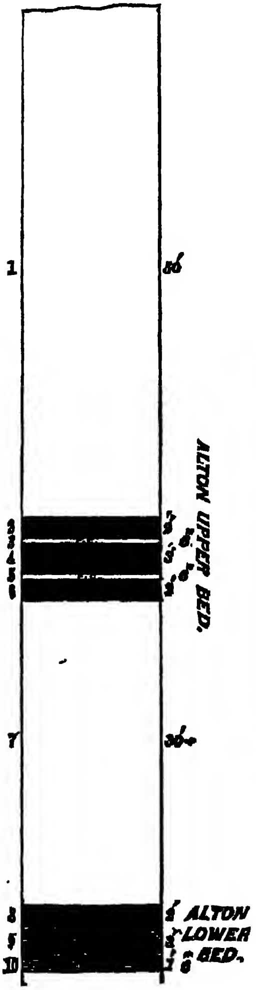


Fig. 55 continued.

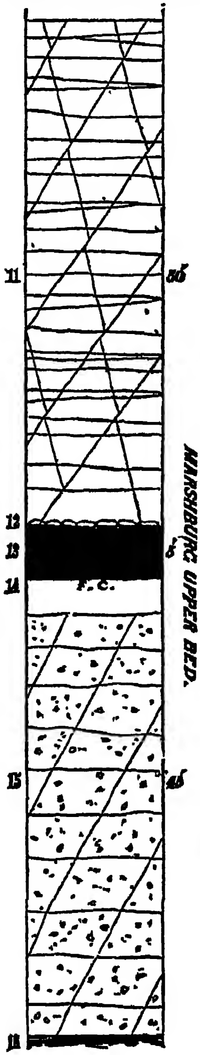


Fig. 56. p. 140.
Alton Upper coal bed.

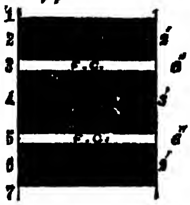


Fig. 57. p. 140.
Alton Lower bed

Fig. 58. p. 140.
Marshburg Upper bed.

4. Coal,			1′ 6″
5. Fireclay,			2′ ±
6. Concealed interval (SS.?),			30′
7. Drift in top of drill hole,		3′ 8″	to 3′ 8″
8. *Coal,*	Alton upper bed,	4′	to 7′ 8″
9. Clay,	Alton upper bed,	6″	to 8′ 2″
10. *Coal,*	Alton upper bed,	2′	to 10′ 2″
11. Clay,	Alton upper bed,	5′	to 15′ 2″
12. *Coal,*	Alton upper bed,	10″	to 16′
13. Fireclay,		2′	to 18′
14. Gray slate,		10′	to 28′
15. Black slate and clay,		6′	to 34′
16. Fireclay,		3′	to 37′
17. Black slate,		4′	to 41′
18. *Coal (Alton lower bed),*		4′ 3″	to 45′ 3″
19. Hard sand rock,		36′	to 81′ 3″
20. Black slate,		5′	to 86′ 3″
21. Dark fireclay and shale,		15′	to 101′ 3″

Strata Nos. 19, 20 and 21 represent the KINZUA CREEK SANDSTONE and the *Marshburg coal* interval.

§ 193. Along the headwaters of Warner brook the following section was constructed: (Fig. 61):

1. Concealed (JOHNSON RUN SS.),	25′+
2. *Coal (Alton upper bed),*	2′ ±
3. Concealed interval,	20′ to 30′
4. *Coal (Alton lower bed),*	4′ ±
5. KINZUA CREEK SANDSTONE,	100′
6. *Marshburg coal interval,*	100′
7. OLEAN CONGLOMERATE,	100′

The *Alton* and *Marshburg* coals have been opened along Warner brook. Near the level of the *upper coal* a drill hole was started and bored to a total depth of 51′ 5″. The drill pierced the *Alton coal group.* The record was reported to me by Mr. Joseph Morse, formerly of Smethport, now of Brooklyn, New York. The record shows an excessive number and thickness of coal beds, and I believe very little dependence can be placed upon its accuracy. It is placed in the report solely as a matter of record.

1. Sandrock,	3′ 6″	to 3′ 6″
2. *Coal,*	10″	to 4′ 4″
3. Clay,	1′ 6″	to 5′ 10″
4. Slate and *coal,*	1′	to 6′ 10″
5. Clay,	1′	to 7′ 10″
6. Slate,	1′	to 8′ 10″
7. Clay,	1′ 8″	to 10′ 6″
8. Bituminous slate,	2′	to 12′ 6″

Fig. 59. p. 142.
Deer Lick Section & Drill hole.

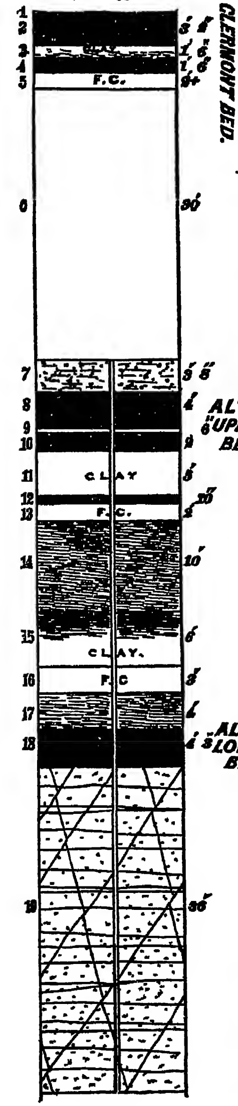


Fig. 59. continued.

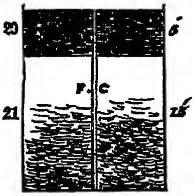


Fig. 60. p. 142.
Clermont coal bed. Deer Lick opening.

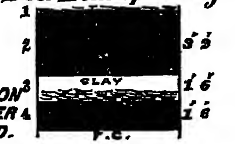


Fig. 61. p. 144.
Warner Brook Section.

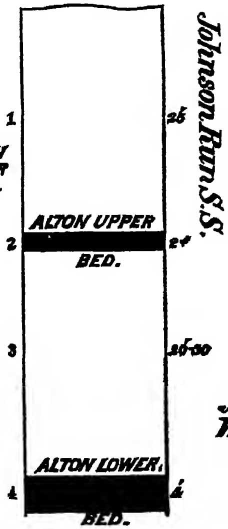


Fig. 61. continued.

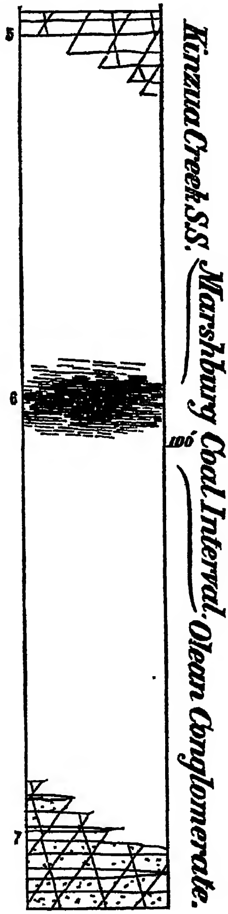
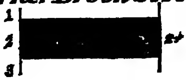


Fig. 62. p. 144.
Alton Upper Coal bed Warner Brook Section.



9. *Coal*,	4′ 6″	to 17′
10. Slate,	11″	to 17′ 11″
11. *Coal*,	2′ 4″	to 20′ 3″
12. Clay,	3′	to 23′ 3″
13. *Coal*,	1′	to 24′ 3″
14. Slate and clay,	9′ 5″	to 33′ 8″
15. *Coal*,	4′ 6″	to 38′ 2″
16. Clay,	3′	to 41′ 2″
17. Slate,	1′	to 42′ 2″
18. Sandy shales,	3′ 3″	to 45′ 5″
19. Blue slate,	2′	to 47′ 5″
20. Clay,	4′	to 51′ 5″

The drill hole is reported to have been started at the bottom of a *coal bed* 2′ 6″ thick.

I regard the whole statement as unreliable.

§ 194. The rocks which are known in the township below the COAL MEASURE CONGLOMERATE, No. XII, have a total thickness of 2219′ (See page 64). They are sub-divided as follows:

MAUCH CHUNK, No. XI, } POCONO, No. X, }	325′
RED CATSKILL, No. IX,	260′*
UPPER CHEMUNG, No. VIII,	1300′*
BRADFOD OIL SAND, No. VIII,	25′†
LOWER CHEMUNG, No. VIII,	309′†
Total,	2219′

§ 195. The MAUCH CHUNK, No. XI, if existing at all, is possibly represented by the black slate immediately below the OLEAN CONGLOMERATE (see page 64).

§ 196. The POCONO, No. X, is not so boldly sub-divided as elsewhere. The SUB-OLEAN CONGLOMERATE is exposed in a railroad cut just below Wernwag station, McK. and B. RR., 2 miles northeast of Clermont. It consists of a hard, yellowish-gray, massive sandstone, very much stained with iron, but containing no pebbles. In the body of the sandstone occurs a bed of soft, rotten, gray shale, 6′ thick. The shale is quite ferruginous. The top of this sandstone is from 50′ to 60′ below the bottom of the OLEAN CONGLOMERATE. The interval between being filled by the characteristic shales and sandstones of the upper member of the

* Average of the thickness of the rocks in the Wilcox wells.

† Wilcox well No. 2.

Fig. 63. p. 142.
Alton Upper coal bed Wernwag Section.

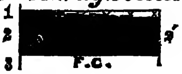


Fig. 64. p. 142.
Wernwag Section.

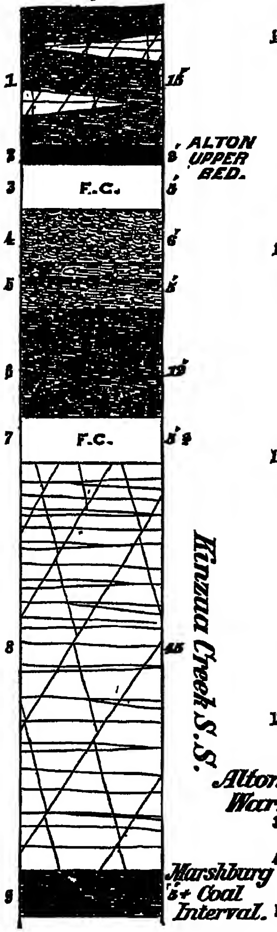


Fig. 64. continued.

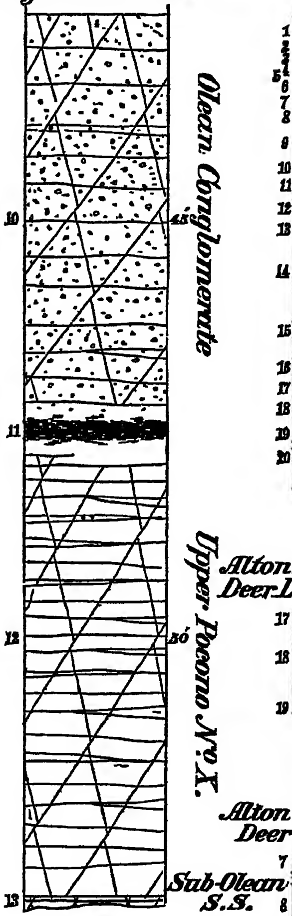


Fig. 65. p. 144.
Alton Lower coal bed. Warner Brook Section.

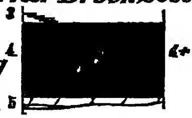


Fig. 66. p. 144.
Warner Brook Drill hole.

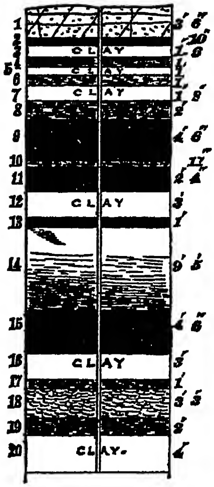


Fig. 67. p. 144.
Alton Lower coal bed. Deer Lick Drill hole.

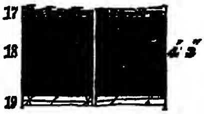
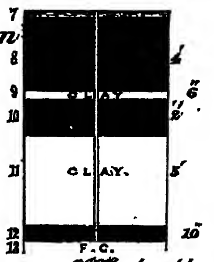


Fig. 68. p. 144.
Alton Upper coal bed Deer Lick Drill hole



C. B. Harden, del.

POCONO. At no other place in the township was an exposure of the SUB-OLEAN found. Loose blocks were found in a number of localities.

The lower POCONO consists of gray slate, shale, and sand; 100′ at the bottom of the formation has been pierced in the Wilcox wells. The details of the strata drilled through in these wells can be better understood from a study of the records and sections than from any general description.

§ 197. *Wilcox well records.*—Through the assistance of Mr. M. M. Schultz, of Wilcox, I have succeeded in obtaining seven extremely valuable and interesting records of wells drilled in the vicinity of that village. They are as follows:

1. Wilcox well, No. 2, or Schultz gas well.
2. Wilcox well, No. 3, or "John's well."
3. Ernhout and Taylor, No. 1.
4. Ernhout and Taylor, No. 2.
5. Bear Creek well.
6. Silver Creek well.
7. Coburn well.

The records of these several wells are given in the description of the townships.

It is due to Mr. Schultz's untiring perseverance that any register of the rocks has been preserved. Most of the records were kept under his personal supervision, and with the greatest of care.

§ 198. *Wilcox Well No. 1, Adams Well.* Owned by M. M. Schultz & Co., situated on the west branch Clarion river, in warrant 2676, 1 mile north of the McKean-Elk county line. This well was drilled by Adams & Babcock* in 1864 (?). According to Mr. M. M. Schultz the well was only drilled to the depth of 1600′± in 1864; afterwards drilling was continued to a depth of 1700′ and it was finally abandoned at a depth of 1785′, where the tools were lost.

*That portion of the record to a depth of 1802′ was originally communicated by Mr. O. N. Adams, formerly of Wilcox, to Prof. Lesley and published by him in the Proceedings of the American Philosophical Society, Vol. X, page 238. The record of the well to a depth of 1609′ was afterwards published in the Petroleum monthly. The undescribed interval of 176′ (stratum 67) has been added on the authority of Mr. Schultz. The record as it appears below is copied from that published in the Petroleum monthly.

Well mouth above ocean in feet,			1646
1. Conductor,	41 to	41 =	1605
2. Slate,	30 to	71 =	1575
3. Red shale,	137 to	208 =	1438
4. Blue sand,	8 to	216 =	1430
5. Slate,	26 to	242 =	1404
6. Red shale,	64 to	306 =	1340
7. Micaceous sand,	21 to	327 =	1319
8. Blue sand,	5 to	332 =	1314
9. Red shale,	31 to	363 =	1283
10. Slate,	13 to	376 =	1270
11. Blue sand,	8 to	384 =	1262
12. Red shale,	31 to	415 =	1231
13. Blue sand,	14 to	429 =	1217
14. Slate,	84 to	513 =	1133
15. Micaceous sand,	47 to	560 =	1086
16. Slate,	77 to	637 =	1009
17. Blue sand,	20 to	657 =	989
18. Slate,	43 to	700 =	946
19. Micaceous sand,	48 to	748 =	898
20. Olive shales,	65 to	813 =	833
21. Micaceous sand,	21 to	834 =	812
22. Olive shales,	11 to	845 =	801
23. Micaceous sand,	18 to	863 =	783
24. Olive shales,	7 to	870 =	776
25. Micaceous sand,	5 to	875 =	771
26. Olive shales,	5 to	880 =	766
27. Chocolate colored mica sand,	9 to	889 =	757
28. Olive shales,	23 to	912 =	734
29. Micaceous sand,	6 to	918 =	728
30. Olive shales,	6 to	924 =	722
31. Red shale,	6 to	930 =	716
32. Micaceous sands,	5 to	935 =	711
33. Olive shales,	2 to	937 =	709
34. Micaceous sand,	10 to	947 =	699
35. Olive shales,	6 to	953 =	693
36. Mixed shales (red and olive),	2 to	955 =	691
37. Olive shales,	38 to	993 =	653
38. Gray sand, light,	3 to	996 =	650
39. Shale very soft,	6 to	1002 =	644
40. Blue clay,	6 to	1008 =	638
41. Olive shales,	65 to	1073 =	573
42. Dark micaceous sand,	36 to	1109 =	537
43. Soapstone, soft mud vein,	2 to	1111 =	535
44. Gray sandstone,	28 to	1139 =	507
45. Slate rock,	25 to	1164 =	482
46. Very hard sandrock,	11 to	1175 =	471
47. Sandstone,	26 to	1201 =	445
48. Slaty rock,	21 to	1222 =	424
49. Hard sandstone and soft slate,	21 to	1243 =	403
50. Slaty rock with sand,	25 to	1268 =	378

51. Mud vein,	1 to 1269 =	377
52. Slate,	4 to 1273 =	373
53. Sandrock,	48 to 1321 =	325
54. "Chalk rock,"	6 to 1327 =	319
55. Mud vein,	17 to 1344 =	302
56. Light sandrock,	18 to 1362 =	284
57. Sandrock,	17 to 1379 =	267
58. Lime (?) and hard shale,	8 to 1387 =	259
59. Soft shale,	25 to 1412 =	234
60. Hard shale, lime and sand,	10 to 1422 =	224
61. Soft blue shale,	15 to 1437 =	209
62. Hard sandrock,	60 to 1497 =	149
63. Sandrock (?),	8 to 1505 =	141
64. Shale and sand mixed,	14 to 1519 =	127
65. Hard shelly sandrock,	38 to 1557 =	89
66. Rock and shales, alternating,	52 to 1609 =	37
67. Interval,	176 to 1785 =	—139

Drilled wet. Afterwards cased at . . . . 400′
Size of hole, ... 5 inches.
Inside diameter of casing, 3¾″; outside, 4″; weight per foot, 5.320 pounds.
Conductor, ... 41′
Heavy fresh water course, ... 60′
Salt water, ... 400′
Mica and iron pyrites abound at . . . . 520′+
Gas and "soot," . . . . 726′ to 820′±
Very soft olive shales, "putty rock," . . . . 840′
"Black gas" downward from . . . . 900′
Red shale at . . . . 940′
Silica abounds, hard and compact, ... 950′
Iron pyrites, ... 1000′
Strong smell in derrick when raising tools, at . . . . 1100′
Gas vein very strong, shooting sometimes 20′ high from top of 26′ sandstone, (stratum No. 47). Gas vein not so strong at bottom of same sandstone.
Gas and soot, with strong odor, ... 1240′
Very small red and white pebbles on tools in 25′ sand (stratum 50), at . . . . 1250′
Gas quite strong at . . . . 1280′
Oil and oil smell in air, ... 1335′±
Plenty of soot at . . . . 1480′
Increasing gas at . . . . 1560′
Strong gas and strong smell at . . . . 1600′

From comparing this record with others, I am disposed to group the strata as follows:

Drift and Lower Pocono, No. X (1 and 2),	71′
Red Catskill, No. IX (3 to 5 (?) incl.),	260′±
Chemung, No. VIII (5 (?) to 67 incl.),	1454′±
Total,	1785′

Drilling is said to have been stopped in a "pebble sand," but I very much question the truth of the report. I was informed that as much as 100 barrels of oil was pumped from this well and shipped to market.

It is interesting to note the correctness of some of Prof. Lesley's conclusions, over fifteen years ago, in regard to the interpretation of this record. He recognized the fact that the *upper red bands* were the representatives of the OLD DEVONIAN RED or CATSKILL No. IX, and that the *lower red bands* might prove to be the western extension of the MANSFIELD RED BEDS, in Tioga county. All the recent facts of the survey confirm Prof. Lesley's views.

§ 199. In the summer of 1877 this well attracted considerable attention from the fact that immense columns of water and gas were thrown periodically (every seven minutes) up into the air to a height of from 85′ to 115′. Great difficulty was experienced in drilling on account of a heavy water vein which was struck at sixty feet depth. This was more particularly the case after the gas veins at 1200 and 1600 feet, respectively, were met. The water would flow into the hole on top of the gas, which it would confine until the pressure of the latter became so great that a huge column of the water would be thrown out of the hole to the annoyance of the drillers. This occurred periodically.

After the tools were lost the upper 400 feet of the well was cased with a four-inch casing having a water packer or seed bag attached to its lower end, effectually excluding the water and rendering the hole practically dry.

The well was then tubed, the sucker-rods were inserted, and a small quantity of oil was pumped, but on account of the great expense of procuring the petroleum, the hole was finally abandoned and the gas allowed free escape into the open air. The gas was afterwards fired and the derrick burned. Seven or eight years ago a wooden plug was inserted into the casing, which only permitted a partial escape of the gas.

About the beginning of the year 1876, when Well No. 2 was started 855′ distant, a pipe connection was made with Well No. 1, and the gas used as fuel in drilling Well No.

2. The surplus gas was conveyed through a 2″ iron tube, having the shape of an inverted letter U, and discharged over a water tank, the water being splashed by the gas over the orifice of the pipe. The pressure of the gas being thus suddenly relieved, a ring of ice an inch thick was formed, which remained under the warmest sun. The ice in this case was produced naturally on the same principle that governs the operation of the Kirk freezing machine.

From the time the gas was first struck by the drill up to the latter part of 1876, it seemed to have, according to Mr. Schultz, a constant flow, but as no measurement was made of its pressure, it is probable that it gradually diminished.

A little oil being found in Well No. 2, an inch pipe was inserted at the depth of 2000 (the well being 2004 feet deep), and it was proposed to utilize the pressure of the gas, which came from *this well*, to force the oil out of the tubing. The resistance offered to the flow of the gas was so great that after a few hours the gas ceased to flow entirely from both wells, Nos. 1 and 2. After thirty-six hours of inactivity it commenced flowing again with greater energy. In the early part of January, 1877, the pressure of the gas seemed to increase suddenly; but not finding a free passage from Well No. 1, on account of the wooden plug which had been inserted into the casing, and which the gas was unable to blow out, the casing was broken at a depth of 175 feet, and the upper portion lifted bodily out of the well. As soon as this occurred the conditions which had existed during the process of drilling were restored, and a column of water was thrown out of the hole every eight minutes to a height of from 80 to 90 feet, and lasting from three to five minutes (M. M. Schultz). This continued until about the middle of May, when the gas from both wells ceased to flow without any obstruction having been knowingly placed in its way.

On the 14th of July, at 1, A. M., the gas made its appearance again and began to throw the water with great energy to a height ranging from 85 to 115 feet; also with a smaller column from three to eight feet high in the intervals between the larger ones; the phenomenon recurring every seven minutes.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Number of observations.	Gas ceases to flow and water commences running in.	Interval.	Water ceases to run in and gas commences rising.	Interval.	Column (of water and gas) commences rising.	Interval.	Column attains maximum height.	Interval.	Height.	Number of pulsations.	Column vanishes.	Interval.	Water ceases to run in and gas commences rising.	Interval.	Column commences rising.	Interval.	Column attains maximum height.	Interval.	Height.	Column vanishes.	Interval.
1					1.24.30	.15	1.24.45	1.	101		1.25.45	1.35	1.27.20	.45	1.28.05	.10	1.28.15	.30	3	1.28.45	1.15
Interval.					6.30		7.15				7.15		7.10		7.35		7.35			7.30	
2	1.30.	.55	1.30.55	05	1.31.	1.	1.32.	1.	99	4	1.33.	1.30	1.34.30	1.10	1.36.40	.10	1.35.50	.25	2½	1.36.15	
Interval.					7.		7.				6.50		7.		6.35		6.40			6.55	
3	*		†		1.38.	1.	1.39.	.50	87	3	1.39.50	1.40	1.41.30	.45	1.42.15	.15	1.42.30	.40	2½	1.43.10	.55
Interval.	14.05		14.05		7.15		7.				6.55		6.45		6.05		6.30			6.20	
4	1.44.05	.55	1.45.	15	1.45.15	.45	1.46.	.45	87	7	1.46.45	1.30	1.48.15	.05	1.48.20	.40	1.49.	.35	5	1 49.30	1.20
Interval.	6.45		7.		6.55		6.40				7.		7.		7.25		6.55			7.15	
5	1.50.50	1.10	1.52.	10	1.52.10	.30	1.52.40	1.05	83	6	1.53.45	1.30	1.55.15	.30	1.55.45	.10	1.55.55	.50	8	1.56.45	1.
Interval.	6.55		6.50				6.35				6.55		7.		7.20		7.25			7.15	
6	1.57.45	1.05	1.58.50				1.59.15	1.25	99	6	2.00.40	1.35	2.02.15	.50	2.03.05	.15	2.03.20	.40	2½	2.04.	
Interval.					13.35		7.				6.40		6.45		6.35		6.30			6.45	
7	*		†		2.05.45	.30	2.06.15	1.05	86	4	2.07.20	1.40	2.09.	.40	2.09.40	.10	2.09.50	.55	2½	2.10.45	.50
Interval.	13.50		13.45		7.		7.				6.55		6.45		6.50		6.55			7.	
8	2.11.35	1.	2.12.35	10	2.12.45	.30	2.13.15	1.	91	5	2.14.15	1.30	2.15.45	.45	2.16.30	.15	2.16.45	1.	4	2.17.45	.35
Interval.	6.45		6.40		6.35		6.45				6.45		6.45		6.40		6.35			6.45	
9	2.18.20	.55	2.19.15	05	2.19.20	.40	2.20.	1.	115	6	2.21.	1.30	2.22 30	.40	2.23.10	.10	2.23.20	1.10	5	2.24.30	.35
Interval.	6.45		7.05		7.05		7.				7.										
10	2.25.05	1.15	2.26.20	05	2.26.52	.35	2.27.	1.	97	6	2.28.										

* The gas did not cease to flow, but rose continuously between the smaller and larger columns.

† The water did not flow in from the pool surrounding the top of the conductor.

During the time that the water columns are thrown out of the well the gas is thoroughly mixed up with the water and is readily ignited. The sight during the flow of the larger column is grand, particularly at night. The water and fire are so promiscuously blended that the two elements seem to be fighting for the mastery.

On July 19th, I closely watched the well for two hours, from 1.19 to 3.22, P. M., and carefully recorded the time of each change in the condition of the water and gas as they spouted from it, noting the number of pulsations in the larger column, and determining its maximum height by triangulation.

On page 153 is a tabulated scheme of the observations from 24 minutes and 30 seconds past one to 28 minutes past two o'clock.*

By an inspection of the intervals between the recurring phenomena, it will be at once seen that there is a marked regularity in the action of the well; in fact, the slight irregularities observed may in a measure be attributed to the personal equation of the observer. In the time included from 10.39, A. M., to 3.15¾, P. M., there were counted 39 of the larger water columns, making the average time between the commencement of each column 6 minutes and 55 seconds.

The accompanying graphical representation will present the action more vividly to the eye It will be noticed that prior to the water columns No. 3 and 7 no water flowed into the hole from the pool surrounding the conductor. Directly after the larger columns vanished, the water flows into the hole, indicating that all the water is blown out of the well.

Occupying every consecutive 7± minutes we have the

---

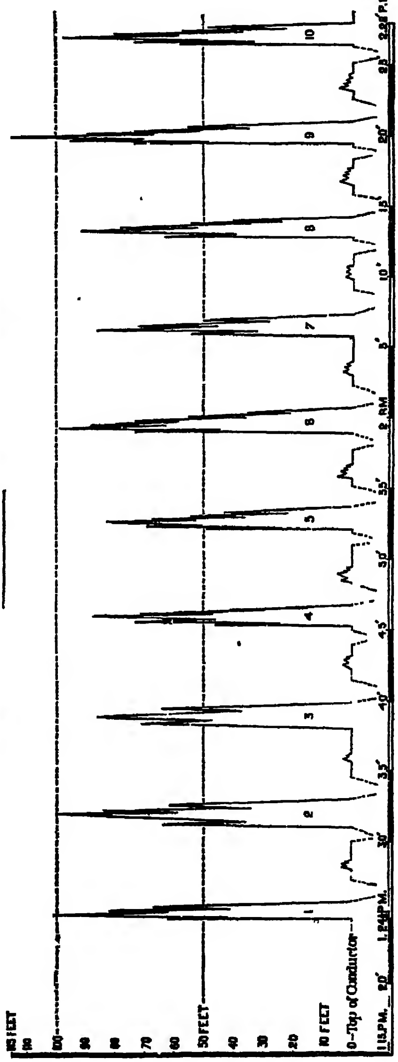
* NOTES.—1. The time in the table is recorded in hours, minutes and seconds, and the height of the column in feet.

2. The intervals in the vertical columns show the time in minutes and seconds or seconds alone, during which each phenomenon lasted. The intervals in the horizontal columns show the time in minutes and seconds between the recurrences of the phenomenon.

3. In columns Nos. 4 and 14, where it is stated "the water ceased to run in," it is meant that no water flowed into the hole from the pool surrounding the top of the conductor. It is probable that the water from the water vein at 60 feet depth flows into the well incessantly.

Graphical Representation of the Wilcox Spouting Water-Well, McKean Co. Pa.

The unbroken line on and above the base is the profile of the Water issuing from the Conductor; the Gas rising from the Well at the same time. The broken line below the base indicates the time that no gas is issuing from the Well, and the time that the Water from the Pool around the Conductor is flowing in. The height of the major pulsation in each column was alone determined.



Observations made July 19th 1877, by Chas. A. Ashburner, M.S. Asst. Second Geological Survey of Pa.

A.A.H.

following sequence of events (See observation No. 9 of the table):

The water from the "water vein" at the depth of 60 feet, and from the pool surrounding the top of the conductor flows into the well for 55 seconds, during which time no gas is detected issuing from the hole. At the end of this time the water from the pool ceases to run in, and the gas rises bubble by bubble for 5 seconds. A column of water and gas now commences rising, makes 6 pulsations, attains a maximum height of 115 feet in 40 seconds, and vanishes in 1 minute. The water from the pool and water vein immediately flows into the well for the second time, continuing for 1 minute and 30 seconds, during which time no gas flows out. At the end of this time the gas rises bubble by bubble for 40 seconds, when the smaller column of water and gas rises, attaining a maximum height of 5 feet in 10 seconds, and vanishes in 1 minute and 10 seconds. The gas still continues to rise but no water flows into the well from the pool for 35 seconds, when the same series of phenomena repeat themselves. Such are the facts.

The explanation of the action may be readily imagined. The pressure of the gas having relieved itself in throwing out of the well the larger column, the water flows into the hole until the pressure of the gas becomes so great again that instead of rising up in small bubbles through the water it rushes out of the well, throwing the water at the same time to a height of from 3 to 8 feet. After the column has vanished the gas continues to rise in great quantities, keeping the water from flowing in from the pool, until the pressure is exhausted. The water now flows into the well till the pressure of gas in its reservoir has increased to such an extent that it thrusts out of the hole the larger column of water to a height of from 85 to 115 feet.

The smaller column of water is probably produced by the gas coming from the smaller vein at 1200 feet depth, while the larger column is thrown up by the gas coming from the greater vein at a depth of 1600 feet. But, of course, neither the one nor the other column is produced by either of the gas veins exclusively, for the gas must be flowing from both

horizons more or less all the time. It will be noticed that more water flows into the hole directly after the larger column has been thrown up, and that the smaller column throws up less water, and *vice versa.*

It was not possible to obtain the pressure or amount of gas coming from the well. The estimated pressure at the time that 175 feet of casing was blown from the well was about 250 fbs. to the square inch. It is possible that the accumulated pressure at the time that the larger water columns are thrown up may be as high as 250 fbs.; but the constant pressure of the gas if unobstructed by the water would probably not be more than 50 fbs.

The action of the Wilcox well is nothing novel, but the observations are interesting and valuable from the fact that a complete record and history of the well have been preserved, and the accompanying facts add much to what has been recorded of similar wells.

As early as 1833,* Dr. S. P. Hildreth, in a paper on the "Saliferous Rock Formation in the Valley of the Ohio" says: "In many wells, salt water and inflammable gas rise in company with a steady uniform flow. In others, the gas rises at intervals of ten or twelve hours, or perhaps as many days, in vast quantity, and with overwhelming force, throwing the water from the well to the height of fifty to one hundred feet in the air, and again retiring within the bowels of the earth to acquire fresh power for a new effort. This phenomenon is called 'blowing,' and is very troublesome and vexatious to the manufacturer."

A well drilled by Peter Neff, Esq., near Kenyon College, in Knox co., Ohio, presented similar features to the Wilcox well. At a depth of 600 feet gas was struck which threw out of the well at intervals of one minute, a column of water to a height of 120 feet. "The derrick set over this well has a height of 60 feet. In winter it becomes encased in ice, and forms a hugh translucent chimney through which, at regular intervals of one minute, a mingled current of gas and water rushes to twice its height. By cutting through

*** See American Journal of Science, July, 1833, quoted in Early and Latter History of Petroleum, by J. T. Henry.**

this chimney at the base and igniting the gas in a paroxysm, it affords a magnificent spectacle—a fountain of water and fire which brilliantly illuminates the ice chimney."

Many of the persons who have visited the Wilcox well during the summer have made a comparison of heights with geysers of the Geyser basin, and I have been repeatedly referred to for information in regard to the latter.

The following table compiled from Dr. Hayden's report of the U. S. Geological Survey, 1871, gives some figures of the geysers along the Fire Hole river, in Wyoming territory.

NAME.	Height.	Diameter.	Time.	Observer.
Grand, . .	200 feet.	6 feet.	20 minutes.	Dr. Hayden.
Giant, ...	130 "	5 "	3 hours.	N. P. Langford.
"	90 to 200 ft.	. . . . . .	3 hrs. 30 min.	Lieut. Doane (1870)
"	140 feet.	. . . . . .	1 " 20 "	Dr. Hayden.
Giantess, . .	250 "	6 to 15 in.	20 minutes.	" "
Beehive, . .	219 "	. . . . . .	18 "	" "

NOTE.—A description of the Wilcox spouting water well was read before the American Philosophical Society, September 21, 1877, and is published in the society's proceedings, vol. 17, page 127.

At the time I presented the paper Mr. Robert Briggs gave a very minute and detailed description of what he considered to be the cause of the action of this spouting well and of hot water geysers in general.

He starts with the assumption that "one of the essentials for the peculiar eruption and periodic discharge which they exhibit, is *the enlargement or funnel shape of the upper portion of the cavity*, so that at or near the final effort of each pulsation, the confined gas or steam shall be suddenly relieved of a part of the pressure of column or head, and the gas or vapor beneath the liquid, in so large a bubble as to form a chamber or reservoir of gas or steam, be allowed to expand against a less pressure than that under which it had generated or been supplied when lifting the column from the bottom of the well to the place where the well enlarged."

Mr. Briggs satisfies the conditions of his hypothesis, in the case of the well, by considering the section of the well to be *funnel-shape;* from the fact the upper 175′ of the well, from where the casing was blown out, is larger than the 225′ immediately below, where a section of the casing remained in the hole. I do not believe that this fact has anything to do with the cause of the well spouting. In the KANE-GEYSER WELL the action was practically the same, and yet it could not be considered funnel-shaped, for the section of the hole was 6″ in diameter from top to bottom.

§ *200. Wilcox Well, No. 2, or Schultz Gas Well.*

Owned by M. M. Schultz & Co.; situated 855′, S. 17° 30′ W. of Wilcox well, No. 1.

Drilling on this well was commenced about the first of the year (1876) and completed in the latter part of August, of the same year. After the drilling was completed to a depth of 2004 feet, an "oil saver" was attached to the iron casing (5⅝ inch), and the gas issuing from the well was conveyed through a two-inch pipe and discharged about two feet above the surface of the water, which partially filled the 250 barrel tank which had been erected. Sufficient oil was passed to show itself as a scum on the surface of the water.

Mr. Schultz conceived the idea of inserting into the well to a depth of 2000 feet, an inch pipe, and by closing the mouth of the casing to utilize the pressure of the gas to force the oil out through the inch tubing.

Mr. Schultz believed that the bulk of the oil which was found in the well was coming from the sand extending from 1795 to 1815 feet, in which the drillers reported that they had "struck" a small quantity of heavy green oil. In this event the immense volume of gas which was issuing from a depth of 1776 feet might more than counterbalance in its pressure the pressure of the oil from a lower horizon, and thus prevent it from filling the hole.

After the tubing was adjusted and the gas confined in the well, as much as two to three barrels were forced out. Mr. Schultz thinks that the tubing during this time must have

been entirely filled with oil, to the exclusion of gas. In this case the pressure of the gas must have been sufficient to raise a column of oil one square inch in section, and 2000 feet high. Of course, such an enormous pressure could only be temporary. The oil flowed from the tubing but for a few moments, the gas then probably became thoroughly mixed up with the oil which from its low temperature quickly congealed and effectually choked the pipe. After a few hours the gas ceased to flow entirely from the well and also from the adjoining well, No. 1. The gas commenced to flow again with greater energy after 36 hours of inactivity, from both wells, Nos. 1 and 2.

In the early part of 1877, the pressure of the gas seemed to increase suddenly. About the middle of May, four months after, the gas from both wells, Nos. 1 and 2, ceased to flow for the second time without any obstruction having been knowingly placed in its way. No gas was found to come from either well till July 14, 1877, when it commenced to flow again. Up to the present time the amount of gas increases and diminishes at irregular intervals. The gas from this well was used as fuel in drilling well, No. 3.

Well mouth above ocean in feet,					1642*
1. Loam and gravel,	30	to	30	=	1612
2. Gray slate,	50	to	80	=	1562
3. Gray slate,	2½	to	8½	=	1559½
4. Gray sand,	42½	to	125	=	1517
5. Red shale,	20	to	145	=	1497
6. Gray sand,	5	to	150	=	1492
7. Red shale,	25	to	175	=	1467
8. Gray soapstone (shale and clay,)	10	to	185	=	1457
9. Red shale mixed with gray slate,	155	to	340	=	1302
10. Streak of soft red shale,	15	to	355	=	1287
11. Gray slate,	62	to	417	=	1225
12. White sand pebble rock containing gas and salt water,	5	to	422	=	1220

*Based on the '1879 profile of the P. and E. R.R., which makes Wilcox 1526.36, (see page 12.) In Vol. XVIII, page 14, proceedings of the American Philosophical Society, I state that the elevation of the well mouth above ocean is 1642′ based on the then (1878) corrected datum of P. and E. R.R., which makes Wilcox station 1527′. The difference between the two elevations of Wilcox station is possibly less than the probable error in the elevation of the well, so that I deem it advisable not to change the elevation of the well which has already been published.

13. Gray slate,	228	to	650	=	992
14. Dark gray slate,	30	to	680	=	962
15. Gray slate and sand,	75	to	755	=	887
16. Gray and red slate mixed,	40	to	795	=	847
17. Gray slate,	60	to	855	=	787
18. Gray slate and hard shell,	5	to	860	=	782
19. Gray slate,	5	to	865	=	777
20. Gray and red slate,	20	to	885	=	757
21. Gray slate,	25	to	910	=	732
22. Red and gray slate,	5	to	915	=	727
23. Gray slate,	30	to	945	=	697
24. Gray sand,	5	to	950	=	692
25. Gray and red sand,	5	to	955	=	687
26. Gray and red slate,	15	to	970	=	672
27. Gray slate,	15	to	985	=	657
28. Gray slate and sand,	5	to	990	=	652
29. Gray slate,	60	to	1050	=	592
30. Gray slate and sand,	5	to	1055	=	587
31. Gray slate and sand,	25	to	1080	=	562
32. Dark gray sand,	15	to	1095	=	547
33. Very hard light gray sand,	5	to	1100	=	542
34. Gray slate and sand containing small bivalve shells,	20	to	1120	=	522
35. Gray slate and hard gray sand,	5	to	1125	=	517
36. Gray slate and soft sand,	10	to	1135	=	507
37. Hard gray sand,	10	to	1145	=	497
38. Soft gray slate,	27	to	1172	=	470
39. Gray sand,	8	to	1180	=	462
40. Gray sand and slate,	5	to	1185	=	457
41. Gray slate containing shell,	15	to	1200	=	442
42. Gray sand containing first strong smell of oil 1205 to 1210,	20	to	1220	=	422
43. Gray slate and hard shell,	15	to	1235	=	407
44. Gray slate,	15	to	1250	=	392
45. Gray slate containing shells,	15	to	1265	=	377
46. Gray slate and clover seed sand,	5	to	1270	=	372
47. Gray slate with hard shell,	10	to	1280	=	362
48. Gray slate,	10	to	1290	=	352
49. Gray slate and hard shell,	25	to	1315	=	327
50. Light gray sand,	10	to	1325	=	317
51. Coarse gray sand,	5	to	1330	=	312
52. Slate,	5	to	1335	=	307
53. Hard gray sand,	5	to	1340	=	302
54 White sand,	10	to	1350	=	292
55. Coarse gray sand,	5	to	1355	=	287
56. Gray slate and shell,	5	to	1360	=	282
57. Gray slate,	30	to	1390	=	252
58. Gray sand,	10	to	1400	=	242
59. Gray slate,	20	to	1420	=	222
60. Gray slate containing shell,	25	to	1445	=	197
61. Gray slate,	15	to	1460	=	182

62. Gray slate containing shell,	105	to 1565	= 77
63. Hard gray sand,	15	to 1580	= 62
64. Slate and shell,	55	to 1635	= 7
65. Gray sand,	35	to 1670	= — 28
66. Coarse gray slate,	9	to 1679	= — 37
67. Dark brown sand containing amber oil, greatest amount near top of sand.*	16	to 1695	= — 53
68. Gray slate,	40	to 1735	= — 93
69. Gray slate and sand,	10	to 1745	= — 103
70. Gray slate and shell,	25	to 1770	= — 128
71. Gray slate and sand,	6	to 1776	= — 134
72. Hard gray sand rock containing a great quantity of gas,	4	to 1780	= — 138
73. Gray slate,	10	to 1790	= — 148
74. Fine sand and slate,	5	to 1795	= — 153
75. Gray sand, upper part containing heavy green oil,	20	to 1815	= — 173
76. Gray and red micaceous sand and pebbles,	20	to 1835	= — 193
77. Gray slate,	55	to 1890	= — 248
78. Gray slate and red sand,	5	to 1895	= — 253
79. Red sand and pebbles,	5	to 1900	= — 258
80. White sand containing oil,	10	to 1910	= — 268
81. White and gray sand containing oil,	20	to 1930	= — 288
82. Gray slate,	74	to 2004	= — 362

Drilled dry. Cased,	541′
Fresh water course,	42½′
Gas and salt water,	422′
Gas increases, salt water,	538′
Gas vein,	1172′
First show of oil,	1205′ to 1210′
Sand containing greatest amount of oil, particularly at top of sand. Oil, amber color,	1679′ to 1695′
Great gas vein,	1776′
Heavy green oil,	1800′
White and gray sand containing oil,	1900′ to 1930′

The strata passed through in this well may be grouped as follows:

Drift and Lower Pocono, No. X, (1 to 4 incl.,)	125′
Red Catskill, No. IX, (5 to 11 (?) incl.,)	260′±
Upper Chemung, No. VIII, (11 (?) to 65 incl.,)	1285′∓
Bradford oil sand, No. VIII. (66 and 67,)	25′
Lower Chemung, No. VIII, (68 to 82 incl.,)	309′+
Total,	2004′

§ 201. *Wilcox Well, No. 3, or "John's Well."*

Owned by M. M. Schultz & Co., and situated 1782 feet north 73 degrees 30 minutes west of well No. 2.

*Probable representative of Bradford "3d" or oil producing sand.

The well was commenced in the early part of October, 1876, and completed to a depth of 1850 feet about the middle of June, 1877.

After the well had been drilled to a depth of 1720 feet, tubing was inserted to a depth of 1684 feet, and it was reported that the well produced, by pumping, a barrel a day for about six months, when it was decided to drill deeper. The tubing was drawn and after losing the tools several times drilling was finally abandoned at a depth of 1850 feet.

The elevation of the top of the well is 1666 feet above ocean; Wilcox station being 1527 feet above the same datum.

Well mouth above ocean in feet,			1666
1. Drift, as follows:	43 to	43	
Loam and sand,	5′		
Loam and gravel,	5′		
Gravel and pebble,	10′		
Gravel and sand,	5′		
Gravel and pebble,	5′		
Gravel and sandrock,	5′		
Quicksand and course pebble,	5′		
Fine sand,	3′		
2. { Gray slate,	2 to	45=	1621
{ Gray slate,	35 to	80=	1586
3. Gray sand,	37 to	117=	1549
4. Red slate or shale,	18 to	135=	1531
5. Red shale (rock hard),	10 to	145=	1521
6. Gray sandrock,	10 to	155=	1511
7. Red shale,	5 to	160=	1506
8. Red slate,	20 to	180=	1486
9. Gray slate,	25 to	205=	1461
10. Red slate,	105 to	310=	1356
11. Red shale,	15 to	325=	1341
12. Gray slate and sand,	15 to	340=	1326
13. Gray slate and shell,	15 to	355=	1311
14. Red slate,	25 to	380=	1286
15. Gray slate,	15 to	395=	1271
16. Gray slate and shell,	20 to	415=	1251
17. Gray sand,	15 to	430=	1236
18. Gray slate,	5 to	435=	1231
19. Gray sandrock,	7 to	442=	1224
20. Clover seed rock,	8 to	450=	1216
21. Gray shale,	15 to	465=	1201
22. Dark gray slate and shell,	75 to	540=	1126
23. Gray slate and shell,	7 to	547=	1119
24. Gray slate,	43 to	590=	1076
25. Hard gray slate,	75 to	665=	1001

26.	Hard dark gray shale,	30 to 695=	971
27.	Gray slate and sand,	5 to 700=	966
28.	Hard gray sand,	15 to 715=	951
29.	Light sand with shale,	5 to 720=	946
30.	White and gray sand,	55 to 775=	891
31.	Hard and fine gray sand,	25 to 800=	866
32.	Fine dark gray sand,	5 to 805=	861
33.	{ Gray slate,	5 to 810=	856
	{ Gray slate and shale,	5 to 815=	851
34.	Fine gray sand,	23 to 838=	828
35.	Red slate,	7 to 845=	821
36.	Gray sand,	25 to 870=	796
37.	Red slate,	10 to 880=	786
38.	Gray slate,	35 to 915=	751
39.	Red slate,	5 to 920=	746
40.	Gray slate,	15 to 935=	731
41.	Soft gray sand,	5 to 940=	726
42.	Soft gray and white sand,	15 to 955=	711
43.	{ Dark gray sand,	5 to 960=	706
	{ Hard gray sand,	5 to 965=	701
44.	Gray sand and slate,	5 to 970=	690
45.	Fine hard dark gray sand,	5 to 975=	691
46.	Red slate,	5 to 980=	686
47.	Gray slate,	35 to 1015=	651
48.	Hard gray sand,	20 to 1035=	631
49.	Gray slate,	35 to 1070=	596
50.	Dark gray sand,	5 to 1075=	591
51.	Gray sand,	5 to 1080=	586
52.	Gray shale,	15 to 1095=	571
53.	Gray sand and very hard shells,	5 to 1100=	566
54.	Soft gray sand,	15 to 1115=	551
55.	Gray and white shell,	10 to 1125=	541
56.	Close soft white sand,	20 to 1145=	521
57.	Hard gray shells,	20 to 1165=	501
58.	Gray slate,	15 to 1180=	486
59.	White and gray sand and pebbles,	10 to 1190=	476
60.	Close white sand,	5 to 1195=	471
61.	Gray sandstone and white pebbles,	20 to 1215=	451
62.	Coarse white sand,	5 to 1220=	446
63.	Silver gray sand,	10 to 1230=	436
64.	Fine white sand,	5 to 1235=	431
65.	Gray slate and shell,	10 to 1245=	421
66.	Gray slate,	40 to 1285=	381
67.	Gray slate and shell,	25 to 1310=	356
68.	Gray sand,	20 to 1330=	336
69.	White sand,	10 to 1340=	326
70.	Slate,	5 to 1345=	321
71.	Coarse gray sand,	10 to 1355=	311
72.	Soft white sand,	5 to 1360=	306
73	Soft gray sand,	5 to 1365=	301
74.	Fine white sand,	5 to 1370=	296
75.	Slate and hard shell,	15 to 1385=	281

76. Gray and hard shell,	30 to 1415=	251
77. Gray slate,	20 to 1435=	231
78. Slate and shell,	5 to 1440=	226
79. Hard gray sandstone,	10 to 1450=	216
80. White sand,	5 to 1455=	211
81. Gray slate,	35 to 1490=	176
82. Hard gray shale,	5 to 1495=	171
83. Gray sand,	5 to 1500=	166
84. Close white sand,	5 to 1505=	161
85. Hard white sand,	5 to 1510=	156
86. Gray slate,	20 to 1530=	136
87. Gray slate and shell,	5 to 1535=	131
88. Hard white sand,	10 to 1545=	121
89. Gray shell,	5 to 1550=	116
90. Gray slate,	25 to 1575=	91
91. Gray sand and shell,	15 to 1590=	76
92. Gray slate,	15 to 1605=	61
93. Gray sand,	20 to 1625=	41
94. Gray slate,	10 to 1635=	31
95. Gray slate and shell,	30 to 1665=	1
96. Gray slate,	10 to 1675=	— 9
97. Gray slate and shell,	10 to 1685=	— 19
98. Crevice full of quicksand,	2 to 1687=	— 21
99. Dark sand containing oil,	3 to 1690=	— 24
100. Crevice containing loose stones and oil,	5 to 1695=	— 29
101. Dark sand and oil,	5 to 1700=	— 34
102. Coarse sand and oil,	5 to 1705=	— 39
103. Loose slate,	10 to 1715=	— 49
104. Light colored slate,	65 to 1780=	— 114
105. "Gas crevice" full of stone and sand,	5 to 1785=	— 119
106. Dark sand,	7 to 1792=	— 126
107. Light colored slate,	16 to 1808=	— 142
108. Hard fine sand,	15 to 1823=	— 157
109. White and red sand mixed, red sand like quicksand,	9 to 1832=	— 166
110. Fine red and white sand,	11 to 1843=	— 177
111. Sandy slate (?),	7 to 1850=	— 184

Drilled dry. Cased,	547′
Drive pipe,	43′
Heavy water course,	52½′
Gas vein,	593′
First strong smell of oil,	1132′
Gas and strong smell of oil,	1182′
Oil in gray shale,	1685′
Crevice full of quicksand,	1687′±
Oil,	1690′
Crevice containing loose stones and oil,	1695′
Oil,	1700′
Oil,	1705′
Pumped,	1720′(?)
Oil,	1780′
Gas crevice full of stone and sand,	1784′
Gas crevice.	1808′

The strata in this well have been grouped as follows:

DRIFT AND LOWER POCONO, No. X, (1 to 3 incl.,)	117′
RED CATSKILL, No. IX, (4 to 14 incl.,)	263′
UPPER CHEMUNG, No. VIII, (15 to 97 incl.,)	1305′
BRADFORD OIL SAND, No. VIII, (98 to 102 incl.,)	20′
LOWER CHEMUNG, No. VIII, (103 to 111 incl.,)	145′
Total, ...	1850′

§ 202. If a comparison be made between the constructed sections of the Wilcox wells, many marked irregularities of structure will suggest themselves. For instance the total thickness of the CATSKILL RED BANDS in the Adams' well (No. 1) is 344′ instead of 260′± as noticed in the subgrouping of the well strata on Plate No. XI. A great many facts have to be taken into consideration in the study of an oil well record other than those given in the driller's report. The conditions under which the well has been drilled, the difficulties encountered, the methods employed in measurement, the frequency of measurement and examination of the sand pumpings, have all to be carefully considered before a final statement of rock structure can be authoritatively made. The Adams' well was a wet hole, that is the water from the fresh "water veins" was permitted to flow into the hole during the whole process of drilling. Strata Nos. 9 and 12 may not have been red shale, but the sand pumpings from this part of the well may have been colored red by *washed out* portions from the Upper beds.

One of the most persistent strata in these wells is the lowest red band in the Upper Chemung (stratum No. 31 Wilcox well No. 1, No. 26 Wilcox well No. 2, and No. 46 Wilcox well No. 3,) (see page 74). The final adjustment of these sections has been made by closely comparing every detail and taking into consideration the probable errors of observation which would tend to vitiate the accuracy of the records.

§ 203. The best natural exposures of the SUB-OLEAN rocks in Sergeant are on the eastern side of Marvin creek valley.

Descending Chapel Hill on the west to Barrett's Corners the following section was constructed:

OLEAN-CONGLOMERATE, No. XII on summit of Chapel hill, (2310',)	10'
Concealed, (No. XI AND UPPER POCONO, No. X,)	60'
Partly concealed. Coarse grained ferruginous sandstone, (SUB-OLEAN-CONGLOMERATE, MIDDLE POCONO, No. X,)	40'
LOWER POCONO, No. X.	
Flaggy ferruginous sandstone containing fossils of Chemung type,	10'
Concealed,	50'
Gray shale with bands of ferruginous limestone, fossiliferous, (spirifer disjuncta, &c.,)	40'
Green and brownish gray flaggy and shaly sandstone,	20'
Hard silicious gray limestone containing fossil fragments,	5'
Olive and gray shales and shaly sandstone,	60'
RED CATSKILL, No. IX.	
Dark red shale,	30'
Concealed,	75'
Light colored red shale containing alternations of green, gray, and yellow shales,	120'
Partly concealed. Composed principally of shales as above,	130'
Barrett's Corners above ocean, (bar,)	*1660'*±

The division between the Catskill and Chemung rocks was not determined. Judging from the thickness of the Catskill strata at Smethport and at the Wilcox wells, the top of the Chemung should lie 100'± above Barret's Corners, or near the top of the last described interval of our section. The *Lower Pocono limestone** is well exposed to the right of the road, at the turn, but a short distance west of the summit. It has a thickness of about 5' is very hard and very silicious, having an irregular, rough fracture. This is the only locality where the limestone was found *in situ* in the township.

§ 204. No good exposures of the Pocono rocks were found in the west Clarion creek valley.

In the vicinity of Williamsville about 175' of the Pocono strata occur above the level of Seven Mile run. A number of exposures were found and the formation shows the same general features as observed elsewhere.

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*I have proposed the name of Marvin creek limestone for this bed, (see page 68.)

NOTE.—Chapel Hill section was constructed and numbered Fig. 69; it has, however, been omitted from the section plates as it shows no features not indicated by the other sections.

CHAPTER XI.

Hamlin Township.

§ 205. Hamlin lies east of Northern Wetmore, south of Lafayette and Western Keating, and south of the center of the county.

Topographically the township is divided into three parts, western and northern, or the valley of Kinzua creek; central, Howard Hill plateau, or "*Big Level;*" eastern and southern, or the valley of Marion creek, and the valley of West Clarion creek.*

The central part is generally known as the northeastern terminus of the *Big Level*, (page 7).

The main features in the topography are similar to those already described for Lafayette.

The greatest elevation *measured* in the township is that of the Howard Hill summit, which is 2268′ above tide. The lowest point is where the Kinzua creek crosses the northern boundary line, at about an elevation of 1600′.

§ 206. The western and central parts of the township lie in the Sixth Bituminous coal basin. Between Howard Hill and Marvin creek valley, the Smethport anticlinal (Fifth axis) passes in a nearly northeast and southwest direction; while the extreme southeastern corner of the township approaches within a third of a mile of the axis of the *Clermont* (*Fourth Bituminous*) *Coal basin.* The southwestern corner is traversed by the Kinzua-Emporium cross anticlinal axis. The axis of the Alton (Sixth) coal basin, no doubt, passes across the northwestern corner of the township; but I was unable to determine its exact loca-

* The West Clarion creek valley really occupies the south central part of the township; although naturally it is the southwestern extension of Marvin valley, the two valleys being separated by a narrow divide.

tion, from the more or less complicated structure, resulting from the Kinzua-Emporium axis.

§ 207. The general dip of the coal measures is away from the anticlinal and toward the synclinal axes. The local dips, especially in the Howard Hill coal field (Plate VIII), are as numerous and even greater in degree than those found in the Alton coal basin.

The elevation of the bottom of the *Olean conglomerate* was determined in but four localities, as follows:

Road crossing Head brook, ...	2040′
Warner brook, ...	1980′±
Huling's well, No. 1, ...	1975′
Kinzua well (mouth of Glad run), ...	1900′±

These points are too few and too distant from one another to serve as a basis for dip estimates. In comparing the elevation of the bottom of the *Olean* on Head brook with its elevation at Buttsville and Huling's well No. 1, it will be noticed that the average dip per mile northwest toward Huling's well is about 20′; while the average dip to the north toward Buttsville is over 40′ per mile.

This greater elevation of the coal measures in the immediate vicinity of Howard Hill, is caused by the intersection of the Smethport and Kinzua-Emporium anticlinals. Where two anticlinals intersect, in *horizontal* strata, a *dome* generally results at the point of intersection.*

This would place the dome at the Seven Mile summit, in Sergeant township; but the bottom of the Olean at this point is some 50′± lower than on Head brook. A glance at the geological map of the county will show that the *dome* lies, in this case, not at the point of intersection, but to the north. Although the summits, in the Howard Hill coal field, are very much higher than those in the Alton coal basin, they do not contain strata very much superior. The summits and strata both descend from Howard Hill toward Lafayette.

§ 208. Mr. Dalson recognized the fact that the measures in the central part of the Howard Hill region were elevated

* The Emporium dome in Cameron county is produced by the intersection of the Boon's Mountain and Kinzua-Emporium anticlinals.

by an anticlinal axis, which, according to his report of 1856, had a general east and west direction. In his report of 1857 it is stated: "It is now ascertained that passing through the south-eastern warrants of the Howard Hill region, this axis (anticlinal) lies on the south side of the dividing ridge, extending in a direction nearly 30° south of west, and crossing the western boundary of the estate near the Tionesta summit."

"The general dip of the strata on the north side of the axis is about 65′ per mile, and on the south side somewhat more; but in either direction it is modified by minor undulations."

"In consequence of the dip, a greater thickness of the coal-bearing strata, and an increased number of mineral beds, are found on each side of the axis in receding from it."*

This anticlinal is what has been more properly termed the *Howard Hill dome.* A glance at the geological map of the township will show this feature, as indicated by the coloring of the outcropping strata.

§ 209. The dip of the coal measures along the *Big Level road* southwest of the *Kinzua-Emporium* anticlinal is about 15′ per mile.

Many of the local dips of the coal measures have been estimated by Mr. Dalson and stated in his reports, to which the reader is referred. The correctness of dip determinations depend upon the proper identification of the coal beds, and unless the latter be conclusive the dips cannot be depended upon.

§ 210. The vertical section of the strata, *actually outcropping* in Hamlin township, extends from the over-shales of the *Dagus coal* bed† found in the Howard Hill summit, downward to the Upper Chemung strata found in Marvin creek valley north of Kasson P. O. Total length of section about 950′.

§ 211. On account of the poor exposures of the coal measures and the scattered and bad condition of the coal

*Second Annual Report, pages 7 and 8.

† See discussion of Dalson's Howard Hill coal section.

openings, it was impossible to construct a detail section. The bottom of the Olean Conglomerate (lower member of Pottsville Conglomerate No. XII) was accurately determined on Head brook and the elevation of the highest stratum on the summit immediately north was ascertained; so that I obtained the total thickness of the coal measures to be about 275'.*

A number of old coal openings which had been made by Mr. Dalson for the McKean, Elk Land and Improvement Company prior to 1856, were visited and their elevations determined; by this means I was enabled to obtain the rock interval between the several coal beds and procure sufficient facts to interpret Mr. Dalson's section and bring it into accord with the sections in the Alton coal basin.

The following is Dalson's section: (Fig. 71.)

1.	Drift,	} 85' (?)
2.	Yellow sandstone, fine grit, hard,	
3.	*Coal* (No. 12, Dalson's report), (Fig. 73,)	4'
4.	Fireclay,	} 10'
5.	Sandstone (?),	
6.	Black slate,	5'
7.	*Coal* (No. 11), (Fig. 74,)	1' 2"
8.	Fireclay,	} 27'
9.	Pale gray bluish sandstone,	
10.	*Coal* (Dalson's "Bond Vein," No. 10), (Fig. 75,)	6'
11.	Fireclay,	} 40'
12.	Sandstone (?),	
13.	Brown, not hard sandstone,	
14.	Gray and white, not hard sandstone,	
15.	Coal slate, clay and balls of iron ore,	
16.	*Coal* (1') (No. 9), (Fig. 78,)	
17.	Fireclay, indurated; with imbedded remnants of plants,	
18.	Fine-grained, close, hard sandstone, white and yellow,	
19.	Fine-grained, soft sandstone, white,	
20.	Coarse, soft sandstone, friable, light pink,	
21.	Hard, pebbly, yellow sandstone (10"),	
22.	*Coal* (No. 8),	10"
23.	Ferruginous shale, including balls of iron ore,	} 14'
24.	Iron ore and coal (3' 2"), (No. 7), (Fig. 77,)	
25.	Fireclay,	} 20'
26.	Compact gray sandstone,	

* According to Dalson 300'.

27. Ferruginous shale, ... 28. Marly shale and indurated clay, including 6″ coal and 5″ iron ore, locally (Nos. 4 and 5), ...	20
29. Compact sandstone, pebbly sandstone, and conglomerate, ... 30. Conglomerate, with loose pebbles, dark colored, ferruginous, ... 31. Compact sandstone, with fragments of coal, ... 32. Indurated clay, ...	40′
33. Coal (Dalson's "Splint Vein," No. 3), (Fig. 79.) . .	4
34. Compact sandstones, ... 35. Black and green shales, ... 36. Fireclay, ... 37. Black shale, resting on a seam of iron ore (3″), . .	38′
38. Hard, fine-grained sandstone, with flakes of shale imbedded, ... 39. Dark and light-colored and ferruginous shale, . . .	15′
40. Iron ore (No. 2), ...	1′
41. Fine-grained sandstone and ferruginous shale, ...	13′
42. Nodular iron ore (No. 1), ...	5′

This section shows a total thickness of 300′, or 264′ exclusive of the drift and yellow sandstone at the top of the section.

§ 212. Coal bed No. 12 of Dalson's report was not seen opened. Mr. Dalson proved the bed under the high summit in the northern part of warrant 2665 (see map of the Howard Hill coal field Plate No. VIII) where he reports "a bed 4′ thick, consisting of pure bituminous coal throughout, with the single exception of a streak (1″ to 2″) of so called gut or soft slate." The elevation of the coal at this point is 2161′ above tide.

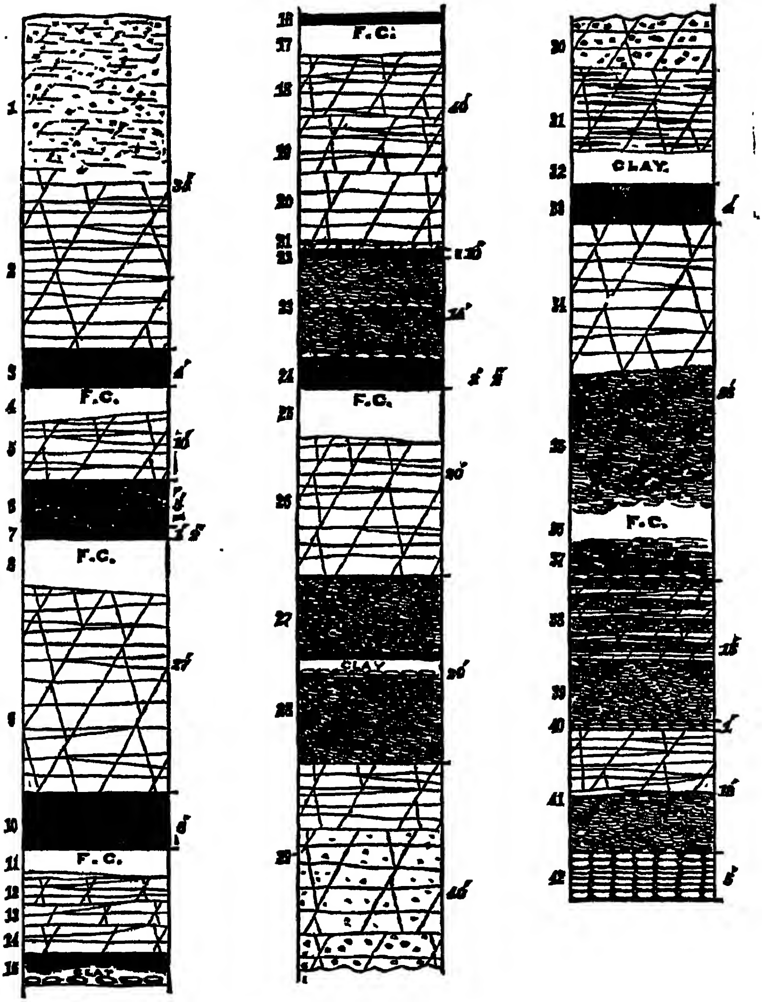
The area of this bed in the township is very limited; beside that already mentioned it is found under the *Howard Hill summit*, north of Head brook and at the junction of warrants 2605, 2665, 2663* and 2703. Here the bed is reported to have been opened in three localities, at the head of Daguscahonda or Wild Cat run.

This coal No. 12 is the representative of Genl. Kane's "gas vein" of the Roberts lot, of the St. Mary's bed and of the Dagus bed (so called "coal C") of the Northwestern Mining and Exchange Company, Elk county. Mr. Dalson states that a coal bed exists at Lafayette occupying a posi-

* Warrant 2663 lies directly east of 2703 on Plate No. XIII it is erroneously numbered 2665.

Fig. 71, p. 171.

Dalson's Section, Howard Hill.



O. B. Harden, del.

tion over bed No. 12 of the Howard Hill section.* Mr. Dalson failed to properly identify the coals in the two sections; the highest coal found at Lafayette is that opened in the Davis mine which is coal No. 10 of the above section.

§ 213. Coal bed No. 11 was not seen nor was its position in the section determined by myself. If it really exists, and Mr. Dalson assures us that it does, its position in the section is such as to indicate it to be the representative of the coal† frequently found under the ferriferous limestone. No limestone has ever been found in the coal measures in the Howard Hill region. In following the dividing ridge from Howard Hill to Clermont, pieces of the *Clermont (ferriferous) limestone* were found in the southeastern corner of the township.

§ 214. The interval given in the section, between coal No. 10 (*Clermont coal*) and coal No. 12, is 43′. I believe this to be an under estimate for an average thickness of the strata between the *Dagus* and *Clermont* coal beds in the Sixth basin. The thickness of these rocks varies but little from 60′ to 70′ wherever I have measured them in McKean and Elk counties.

§ 215. Coal bed No. 10 of Dalson's section is reported to have an average thickness of 6′, including the shale and slate partings which are generally found in the bed. On the headwaters of Wild Cat run, in the northwestern part of warrant 2663 (opening No. 10*a* Plate No. VIII), a shaft was sunk through the coal and the following section exposed: (Fig. 76.)

Detritus,		—
Coal slate,		3″
Bituminous coal, bright,		4″
Bituminous coal,		11″
Cannel coal,		6″
Slate and clay,	1′	5″
Coal intermixed with slate,	2′	8″
Bright bituminous coal,		5″
Fire clay,		—

*First annual report of the board of directors of the McKean, Elk Land and Improvement Company, page 15.

† Scrubgrass coal of Mercer, Lawrence and Venango counties.

Fig. 72. p. 176.

Warrant 2665.

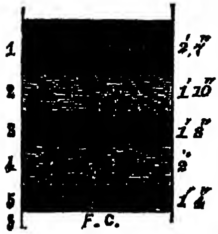


Fig. 76. p. 174.

Wild Cat Run Coal bed.

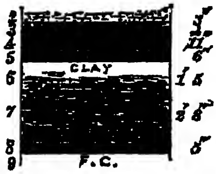


Fig. 73. p. 171.

Coal bed No. 12. Dalson's Section

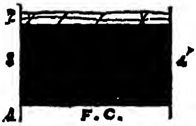


Fig. 77. p. 171.

Iron Ore & Coal bed No. 7. Dalson's Section.

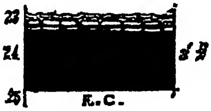


Fig. 74. p. 171.

Coal bed No. 11. Dalson's Section.

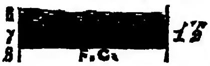


Fig. 78. p. 171.

Coal bed No. 9. Dalson's Section.

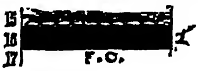


Fig. 75. p. 171.

Coal bed No. 10. Dalson's "Band Vein."

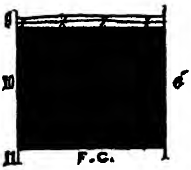


Fig. 79. p. 172.

Coal bed No. 3. Dalson's "Splint Vein."

The total thickness of the bed here is 6′ 3″.

At a point about three fourths of a mile east of north of the above locality (warrant 2665) a shaft was dug through the same bed, here the section measured: (Fig. 72.)

Bituminous coal,	2′ 7″
Slate,	1′ 10″
Bituminous coal,	1′ 8″
Slate,	2 0″
Bituminous coal,	1′ 4″
Fire clay,	—

The total thickness of the bed, including the two slate strata is 9′ 5″.

In describing this coal Mr. Dalson says:* "No. 10 is a coal-vein which has been opened in different localities of the region, and is named the *Bond vein* owing to a drift into it on the property of Mr. Bond, north of the Kinzua river. Within the Howard Hill section it has been opened in 4 shafts, on branches of Wild Cat run, in warrants 2663 and 2665. It appears to vary in thickness from 5½′ to 6½′. Owing to a parting of slate in the middle of the vein, its quantity of pure coal is reduced to 5′, and locally perhaps to 4½′. But the presence of this unprofitable bench of slate is compensated by a bench of cannel coal, which is found in variable thickness, (apparently from 6″ to 1′ 6″,) in the upper part of the vein."

"From a comparison of specimens taken at 5 different openings on this bed, in warrants 3153, 3093, 2686 and 3243, it appears that proceeding southward the coal of this vein changes its character from a bright laminated bituminous to a genuine cannel coal."†

I believe Mr. Dalson's conclusion that this coal is the same as the *Alton bed* (*Bond vein*) at Bond vein is correct, and yet it seems probable that the place which he has assigned to it in the general section of the coal measures is wrong.‡

* First annual report McK. E L. and I. Co., page 14.

† Second annual report, page 9.

‡ Mr. Dalson seems to have mistrusted his conclusions stated in his first report. In this report he calls No. 10 coal the "*Bond vein*" (page 14), while in his second annual report he calls No. 8 coal the "*Bond vein*" (page 9); but No. 8 is the representative of my *Alton upper coal bed*, while the bed

No. 10 of the section is the place of Clermont coal bed, while the coal bed which he has described above as No. 10 is unquestionably the representative of the Alton middle coal and not of the Clermont. Such an error of identification could readily be made when it is remembered that the Howard Hill coals are subject to varying local dips just as the coals are in the Alton coal basin.

§ 216. No. 9 coal is reported "of too small thickness to merit any attention." "It is overlaid by iron ore in balls." This occurs in the horizon of the JOHNSON RUN SANDSTONE.

§ 217. The interval of 40′ between No. 8 and No. 10, composed of sandstone, slate, &c., is the representative of the Johnson run sandstone. Most of the summits in Hamlin township are formed by this sandstone. The sandstone has the same general character as in Lafayette.

Judging from the thickness determined for this sandstone, in the townships next adjoining Hamlin, I believe Dalson's estimate of 40′ to be too small.

§ 218. Coal No. 8, according to the interpretation put upon the section, is no doubt the representative of the *Alton upper bed* which has been mined at Buttsville (page 51).

§ 219. The coal and iron ore, bed No. 7, is in the position of the *Alton middle coal* (see § 86). The *lower Alton coal bed* has no representative in the section.

§ 220. The interval between Nos. 7 and 3, and which according to Dalson is 80′ thick, represents the KINZUA CREEK SANDSTONE. It is composed of alternating shale, sandstone and conglomerate and contains strata Nos. 4, 5 and 6. The former and latter being thin iron ore beds, while No. 5 is a coal bed only 6″ in thickness. None of them are workable.

The thickness assigned to these strata is too great; from my own determinations it does not exceed 50′ to 60′.

§ 221. Mr. Dalson reports that coal No. 3 is the lowest

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which he describes is my Alton middle bed. Mr. Dalson was evidently very uncertain as to the proper identification, and I have failed to find any facts in his report to invalidate my conclusion that the bed which he calls the "*Bond vein*" should occupy the position of the "coal and iron vein No. 7 of his general section.

"vein" and consists of a coal of superior quality. He states that the average thickness of the bed is 4′ and is among the *most valuable* beds of the region.*

This coal bed is the representative of the upper Marshburg bed; it has never been economically worked nor do I believe it to be a commercial bed.

§ 222. The shales and sandstones between Nos. 1 and 3 represent the OLEAN CONGLOMERATE. The total thickness in the section is 67′, which exceeds by 10′ to 15′ the thickness which I should assign to it. It contains a thin iron ore bed in the lower part, which will probably never be found of workable size. The series is immediately underlaid by a nodular iron ore bed with a reported thickness of 5 feet. The bottom of the POTTSVILLE CONGLOMERATE is invariably defined by an iron ore bed or ferruginous shale. Mr. Dalson notices the existence of a "lower conglomerate containing coarse pebbles" below the Olean but he does not estimate its thickness or exact position in the section. This conglomerate is evidently the SUB-OLEAN which has been placed about 50 feet below the Olean in Hamlin township.

§ 223. The number of coal beds in Hamlin township which have a workable thickness may be reduced to three; the *Dagus* bed, (No. 12) the *Clermont* bed (No. 10) and the *Alton middle* bed (No. 7).

The area covered by the *Dagus* bed is quite limited (page 46). Outside of the Howard Hill region there are but few and detached areas underlaid by the *Clermont* bed. The *Alton middle* bed occurs under those portions of the township having the darkest color on the county geological map (Plate X).

The purity of these three coals is unknown, from personal examination; as they are found in the same synclinal or basin as the Lafayette coals, and as there are no marked changes in the geological features of the localities it is reasonable to suppose that the commercial value of the Hamlin and Lafayette coals is about the same.

§ 224. The SUB-OLEAN measures have the same general character, as in Lafayette and Bradford, although slightly

* Second annual report, page 9.

thicker. The SUB-OLEAN CONGLOMERATE is about 40′ thick and is separated from the Olean by 50± of shales and flaggy SS's. The shales and sandstones below the *Sub-Olean* have a thickness of about 235 feet; so that the distance from the bottom of the Olean to the top of the reds No. IX is 325′ as against 240′ in Lafayette at Lewis run.

The conglomerate, which I have called the middle member of the Pocono, No. X, changes its character very much in this township. In the valleys of Glad run, south branch of Kinzua creek, Fife run, Windfall run and Kinzua creek north of Howard Hill, it has the same character as in Lafayette (page 194), Hamilton (page —) and Bradford (page —); but as we go toward the eastern part of the township into the valleys of Marvin creek and Warner brook it deterioates from a large flat pebble conglomerate into a fine grained ferruginous sandstone.

A number of wells have been drilled through these rocks. Records of two of Mr. Huling's wells were obtained and are given below.

§ 225. Huling's Well No. 1, (old Owl Well,) south bank of Kinzua creek, in northern part of warrant 3084, Hamlin township.

Drilled summer of 1878. Authority Mr. Seth Hulings.

	Well mouth above ocean in feet,				+1625
1.	Conductor,	50′	to	50′	= +1574
2.	Red rock,	100	to	150	= +1475
3.	?	600	to	750	= + 875
4.	Red rock,	50	to	800	= + 825
5.	?	175	to	975	= + 650
6.	Shells and sand,	100	to	1075	= + 550
7.	?	200	to	1275	= + 350
8.	Sand, slate and shells,	270	to	1545	= + 80
9.	Bradford oil sand,	68	to	1613	= + 12

This well was the first drilled in the Kinzua district. Daily production about 30 barrels during the first year after completion.

§ *226. Huling's Well, No. 3.*

North of Kinzua creek in western part of warrant 3076, Hamlin township. Drilled winter 1878 and 79. Finished March, 1879. Authority drillers.

	Well mouth above ocean in feet,		+1715
1.	?	150 to 150=	+1565
2.	Red shale,	50 to 200=	1515
3.	Gray shale,	25 to 225=	1490
4.	Red rock,	85 to 310=	1405
5.	Pebble rock,	20 to 330=	1385
6.	Red rock,	20 to 350=	1365
7.	Sand shale,	20 to 370=	1345
8.	Red rock,	30 to 400=	1315
9.	Sandy shale,	20 to 420=	1295
	Streak of red rock,	420=	
10.	?	55 to 475=	1240
11.	Blue slate,	315 to 790=	925
12.	Slate and shale,	5 to 795=	920
	Light red rock,	795=	
13.	?	100 to 895=	820
14.	Slate and shale,	20 to 915=	800
15.	Red rock,	15 to 930=	785
16.	Slate,	20 to 950=	765
	Red rock,	950=	
17.	?	45 to 995=	720
18.	Slate,	5 to 1000=	715
	Dark red rock,	1000=	
19.	?	100 to 1100=	615
20.	Slate and shell,	10 to 1110=	605
21.	Pebble sand,	15 to 1125=	+ 590
22.	Slate and shell,	175 to 1300=	415
23.	Shale,	60 to 1360=	355
24.	Slate and shell,	15 to 1375=	340
	Sand, "2d sand,"	1375=	
25.	?	75 to 1450=	265
26.	Pebble sand,	15 to 1465=	250
27.	Slate and hard shells,	200 to 1665=	50
28.	Sand, "3d sand,"	65 to 1730=	15

Drilled dry. A show of oil was found at a depth 1695. A salt water vein was encountered at 1700. The well was reported to be "dry" and at the time the record was obtained, July 2, 1879, the derrick had been pulled down and the well abandoned.

The rocks pierced in this well may be grouped as follow:

Drift and Lower Pocono, No. X, (stratum, 1,)	150′
Red Catskill, No. IX, (2 to 8 incl.,)	250′±
Upper Chemung, No. VIII, (8 to 27 incl.,)	1265′∓
Bradford oil sand, (stratum, 28,)	65′
Total depth,	1730′

The thickness of the Upper Chemung in this well is less than at any other locality in the county (see Plate XI).

The depths were determined by rope measurement; so that the discrepancy is probably due to errors of measurement, rather than to an actual thinning of the rocks themselves.

§ 227. *Kinzua Well or "Dry Hole," P. C. L. and P. Co.*

Owned by the Producers Consolidated Land and Petroleum Company of Bradford, situated on Kinzua creek, near the mouth of Glad run, in warrant 3122, Hamlin township, McKean county, and about five miles northeast of Kane. The land upon which this well is located together with the adjoining tracts are part of those originally belonging to the "McKean Elk Land and Improvement Co.," General Thomas L. Kane, Supt.

The well was drilled in the spring of 1877, and the record was furnished by Mr. L. C. Blakeslee, Superintendent P. C. L. and P. Co.

The elevation of the top of the well as determined by Mr. J. W. Murphy of Wilcox, is 52 feet higer than Wilcox Well, No. 3, or 1718 feet above ocean.

Well mouth above ocean in feet,		1718
1. Surface clays, &c.,	32 to 32=	1686
2. Soft slate,	78 to 110=	1608
3. Mud slate,	95 to 205=	1513
4. Red rock,	50 to 255=	1463
5. Slate rock,	38 to 293=	1425
6. Red rock,	57 to 350=	1368
7. Sand "shells" and red rock mixed,	15 to 365=	1353
8. Slate,	35 to 400=	1318
9. Sand "shell,"	10 to 410=	1308
10. Slate,	346 to 756=	962
11. Mixed slate and hard slate rock,	361 to 1017=	701
12. Mixed slate and sand "shells,"	358 to 1375=	343
13. Hard slate mixed with sand and "pebble shell,"	370 to 1745=	— 27
14. Slate and sand alternating,	40 to 1785=	— 67

Drilled dry. Cased at	370′
Heavy sand "shell" at	1017′
Sand at	1745′
Slate at	1760′
Sand at	1768′
Slate at	1780′
Salt water found in sands at	1745′ and 1768′

Mr. Blakeslee reports that no "good show" of oil was

found. A small gas vein was struck, position not stated. Elevation of the bottom of the Olean Conglomerate on the P. & E. RR. four miles due southwest from the Kinzua Well is 1868 feet. The calculated elevation of the same horizon at the well is 1900 feet.

Stratum No. 4 of this record is no doubt the top of the red Catskill No. IX; but the thickness given for this formation (indicated by the thickness of red rock) is very much less than at points in the adjoining townships. If the record is correct the color of the lower part of the Catskill at this well is not red. I do not believe the section to be sufficiently reliable to warrant such a conclusion. Comparing this record with those of the Hulings, Coburn and Wilcox wells and estimating from the top of the Catskill, No. IX, it seems quite probable that the drill pierced the Bradford oil sand (upper part).

§ 228. Mr. Dalson reports* that he found a limestone bed in the lower part of his section, apparently immediately below the *Sub-Olean Conglomerate*. I failed to find any indications of this limestone in the township. It seems quite probable that the limestone which Mr. Dalson noticed, is the same stratum which was found in the adjoining townships about 250′ below the bottom of the *Olean Conglomerate*, (page 68).

*First annual report, page 17.

Chapter XII.

Lafayette township.

§ 229. Lafayette lies east of Corydon and Hamilton, south of Bradford, and a little west of the center of the county. It might be termed the *Plateau township* of McKean county, since it includes broader flat summits, and more of them, than any other. They vary in elevation above tide from 2100′ in the southern to 2225′ in the northern part. The drainage of all Lafayette, except the northwest corner is through Tuna and Kinzua valleys, which descend, with gentle slopes, to 1550′ (Tuna) and 1500′ (Kinzua) before leaving the township, and sub-divide the upland into three groups of subordinate plateaux: the Alton, the Lafayette and the Marshburg.

§ 230. *The Alton plateau* spreads north into Bradford township, east into Keating and south into Hamlin. Its greatest length on a southwest line through Alton is 11 miles. Its greatest breadth just north of Alton, Bond Vein and Buttsville, is 5 miles. The surface nearly flat, but gently falling southward with the dip, as do the other plateaux to the west of it, is generally formed either by the *Kinzua creek sandstone* or by the *Johnson run sandstone;* but, around Alton and Buttsville, by still higher measures. East of it are the small and comparatively rounded summits between the branches of Cole creek; south of it beyond the Kinzua, is Howard Hill with its coal basin; west of it, beyond the Tuna east branch and Pine run, is the Lafayette plateau.

§ 231. The *Lafayette plateau,* the smallest of the three, occupies the central part of the township, with a length N. E. and S. W. of five miles, and a maximum breadth, north of Lafayette, of two and a half miles.

In its knobs are found the highest rocks of the township; Davis' Hill, southwest of Lafayette, being capped by strata next underlying the *Clermont (Ferriferous) limestone.* Yet these summits are lower than those of the Alton plateau to the east, and of the Marshburg plateau to the west, showing that this Lafayette plateau occupies a geological depression, and lies more nearly in the *center line* of the Alton coal basin.* (See Plate XII.)

§ 232. *The Marshburg plateau*, west of the Tuna south branch, Lewis run and Wintergreen run, is almost as large as the Alton plateau, but with a more irregular outline; being deeply ravined along its eastern edge by the branches of Lewis run, and nearly bisected on the south by Turnip run.

Marshburg stands on its northwestern edge, between the heads of Chapel fork of Kinzua creek and the Tuna west branch. A long serrated prong of the plateau extends southwest through the center of Hamilton township.

The maximum length of the Marshburg plateau is about ten miles, measured from just west of Custer City, through Marshburg, to the extreme south outcrop of the *Kinzua creek sandstone*, west of Turnip run.

Most of the Marshburg plateau is immediately underlaid by the *Johnson run sandstone.*

§ 233. Lafayette township is in the Sixth Bituminous coal basin.† The stratification is so nearly horizontal, that the dip (to the southwest) is only about 20′ to the mile, as calculated by observations in the Conglomerate series; but observations in the underlying Chemung rocks, make the dip somewhat greater.‡

This exceedingly slight dip makes the study of details difficult, in spite of the simplicity of the geology as a whole.§ The regularity of the Conglomerate series is evi-

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* It will be noticed that the Alton coal bed, in the vicinity of Alton, Bond Vein, and Buttsville, has been opened at the lower level than at any other point in the township. This is a local depression, and does not lie as near the center line of the basin as the Lafayette plateau. (See page .)

† According to the nomenclature of the First Geological Survey.

‡ This will be explained further on.

§ After I had made a general reconnaissance of the entire county, my first

dent, on inspecting the map of the Alton coal basin (Plate XII); for the outcrop lines closely coincide with the contour curves.

§ 234. *The general dip of the coal measures* has been estimated from the elevation of the bottom of the Olean Conglomerate, given in the following table:

Elevation of the bottom of the Olean Conglomerate.

At Alton,	1878′	At Marshburg,	1975′
" Bond Vein,	1912′	" Huling's oil well No. 1,	1975′
" Matthews farm,	1914′	" Camp Lot,	1980′
" Buttsville,	1924′	" Big Shanty,	1990′
" Seven Foot Knoll,	1940′	" Coal opening Chappel Fork,	1995′
" Lafayette,	1945′	" Prentice Mills,	2040′
" Whitman farm,	1964′	" Custer City,	2140′
" Bullock farm,	1970′	" De Golier,	2145′

The absolute elevation of the bottom of the Olean was not, in all cases, determined by direct measurement; it was not exposed or located by drill holes in a number of places. Where the elevation has been computed, it has been done by reckoning down, from some well defined stratum.

From these figures I have estimated the average dip per mile in a number of directions. It must be understood that the dips which are recorded only serve to give a general idea of the structure; they cannot in all cases be taken as guide dips for the location of coal openings. The coal beds are subject to a number of local dips, which are generally greater in degree than the average dip between two points several miles apart.

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instrumental observations were made in this township. Here the underground structure had been more confused than anywhere else by local reports. The natural exposures, to say the least, are as rare as in any other part of the county. Through the kindness of Mr. James E. Butts and Mr. L. C. Crawford, I was enabled to procure the records of nearly fifty drill holes, which had pierced the coal measures to depths varying from a few feet to one hundred and forty feet. From this fact I deemed it advisable to commence my examinations in Lafayette.

Any engineer, who has had any experience in making coal explorations, knows how difficult it is to obtain reliable sections of the coal measures from the records of drill holes.

These records, however, have been kept and reported by different parties; so that by a close study of each record and a careful comparison with others, it was possible to check the accuracy of all, without necessarily assuming a fixed standard of structure.

The dip given for the conglomerate cannot be taken to represent the dip of the Bradford Oil Sand.

The rocks between the conglomerate and sand, in going from Big Shanty south to Kinzua creek, thicken 100 feet; this fact would necessitate the oil sand having a greater dip to the south than the conglomerate.

Table of Dips.

FROM	TO	Distance in miles.	Direction.	Dip per mile.
Custer City, ...	Prentice Lewis Run well,	$2\frac{5}{8}$	S. 3° 45′ E.	38′
Prentice Lewis Run well,	Big Shanty, ...	$1\frac{1}{2}$	S 11° 00′ E.	33′
Whitman farm, ...	" "	$1\frac{3}{4}$	N. 34° 00′ E.	13′
Bullock farm, ...	Whitman farm, ...	$1\frac{1}{8}$	N. 33° 15′ E.	5′
" "	Lafayette, ...	$1\frac{1}{4}$	S. 24° 45′ W.	20′
Lafayette, ...	Matthews farm, ...	1	S. 25° 30′ W.	31′
Huling well, No. 1, . . .	" "	$1\frac{1}{4}$	N. 5° 00′ W.	41′
Custer City, ...	Marshburg, ...	$6\frac{1}{4}$	S. 56° 15′ W.	26′
Coal op'g, Chappel Fork,	"	1	N. 28° 30′ E.	20′
Marshburg, ...	Lafayette, ...	$5\frac{1}{2}$	S. 40° 00′ E.	5′
Lafayette, ...	Alton, ...	8	S. 89° 00′ E.	22′
Camp Lot, ...	Lafayette, ...	2	S. 81° 30′ E.	17′
Whitman farm, ...	Alton, ...	$2\frac{7}{8}$	S. 42° 00′ E.	30′
Bond Vein, ...	"	$\frac{5}{8}$	N. 87° 00′ W.	54′
Buttsville, ...	Bond Vein, ...	$1\frac{1}{8}$	N. 45° 00′ W.	11′
Huling's well No. 1, . . .	Alton, ...	$4\frac{1}{8}$	N. 54° 30′ E.	23′

The magnetic bearings in the table are recorded from the magnetic meridian of 1793 and '94, which was N. 42′ W. of the true north and south line.

From Prentice Lewis run well to Big Shanty there is a strong southern dip in the Olean Conglomerate.

At the original Prentice Lewis run well, on the Moody tract, the oil sand was reported to have been struck at a depth of 1378 feet; the elevation of the top of the well being 1605 feet. The elevation of the top of the sand is 227 feet.

In the old King & Co's. well, which was the first well drilled at Big Shanty, the top of the sand was reported at a depth of 1545 feet. The top of the well is 1672 feet above tide; so that the elevation of the top of the oil sand would be 127 feet.

If these two sands, which have been reported, are the same geological strata, there would be a dip between the two wells of 100 feet, or at the rate of 65 feet to the mile. The elevation of the bottom of the Olean, at the Prentice well, is *2040* feet and at the Big Shanty well about *1990* feet; a total dip to the south of 50 feet or at the rate of about 33 feet to the mile.

The records are not sufficiently reliable to assert a thickening of 50 feet to the south, of the strata included between the Olean Conglomerate and oil sand. It is quite probable there is some thickening between these two wells, for the Gray Pocono (No. X.) rocks are 350 feet thick on the Kinzua and only 250 feet thick at Big Shanty.

The center of the Alton coal basin is at Alton, where the elevation of the bottom of the Olean Conglomerate is 1878 feet, being found at a lower elevation than at any other point in the township. This basin represents a dimple in the Sixth bituminous basin, with quaquaversal dips toward Alton. The Kinzua-Emporium anticlinal produces a northeast dip in the strata from Huling's Well No. 1 to Alton, at an average rate of 23′ per mile. The northeast and southwest dips in the basin are the greatest; the greatest dip which has been determined in the basin for a short distance is that of 58 feet in $\frac{5}{8}$ of a mile between Bond Vein and Alton, while the lowest average dip per mile, is between Marshburg and Lafayette (5 feet).

There is a local depression in the strata, at the northeastern limit of the Lafayette plateau. At this point the dips are reversed and are in a northeast direction. Between the Bullock and Whitman farms they dip at the rate of 5 feet per mile to the northeast, and from the latter farm to Big Shanty the dip is in the same direction, at the rate of 13 feet per mile. This local depression, in the vicinity of Big Shanty, may extend down to the Bradford oil sand. In fact, we have every reason to believe that it does; there is no evidence of such a non-conformability in the strata, as would otherwise have to occur.

A close inspection of the dips, given in the above table, will show the warped character of the strata. The importance and

intensity, of these comparatively low dips, can only be appreciated by the mining engineer. The greatest dip shown would make such a gradual grade in a railroad track, that it could only be determined by the most practised eye. Theoretically, they are so low that the strata might almost be consider horizontal; and yet practically, even the lowest dip is of the greatest importance.

In mining economy, a dip of even 10 feet to the mile may introduce a new element, into profit and loss account, which may render the working of the coal bed unprofitable. At the present condition of the bituminous coal trade, it requires a superior coal, to make it pay to pump the mine. The difficulties which will always beset the miner, in working the Lafayette township coals, are such that the relative cost of mining will always be high, even with the strictest mine management. When the inferior quality of the fuel is taken into consideration, it may be safely asserted that it can only be under the *most favorable* or *exceptional* conditions, that the Alton coals can be profitably mined, as a competing coal in the market.

Unfortunately the Alton coal bed, which is possibly the most important coal in the Alton basin, is over 50 feet below water level at Alton, where it lies lower than at any other point in the basin.

Here is the natural point for mining the coal and yet all the drainage water of the mine would have to be pumped.

§ 235. The vertical section of measures, *actually outcropping* in Lafayette township, extends from the *Clermont* (*Clarion*) over rocks (capping the hill at the old Davis coal mine near Lafayette) downward, to shale beds in the upper part of the Chemung formation near Lewis run, 1050′.

Oil well records carry the column of rocks further downward,* 1250′ to 1300′.

The total column of Carboniferous and Devonian rocks, known in Lafayette township, is about 2300′.

***No detailed oil well record has ever been kept in the township, so that our knowledge of the local character of the individual Chemung strata is yet imperfect.**

Some of the oil wells have been commenced in the coal measures, and it is to be regretted that the drillers have not appreciated the importance of keeping careful records.

§ 236. The members of the Carboniferous formation, however subject to sudden *local* variations of character, are nevertheless generally distinguishable from one another by strongly marked individual features, so that it only needs close examination to make out the geology, even when it seems at first sight confused.

The accompanying section has been compiled from various scources, and represents the rock succession from the top of the Davis hill down to the bottom of the Olean Conglomerate, the lower member of the Pottsville No. XII.

	Clermont (*Ferriferous*) *limestone*, (summits too low to contain it,)	—
1.	Sandstone, shale and slate,	37′
2.	*Clermont* (*Clarion*) *coal*,	5′±
3.	Fireclay,	5′∓
4.	JOHNSON RUN SANDSTONE (pebbly), and slate,	50′
5.	*Alton Upper coal*,	2′
6.	Fireclay, (2′).	?
7.	Blue and black slate and sandstone,	12′
8.	*Alton Middle coal*, (2 or more benches,)	5′
9.	Fireclay, sandstone and slate,	10′
10.	*Alton bottom coals*, (sporadic,)	2′
11.	KINZUA CREEK SANDSTONE, conglomerate and slate,	50′
12.	Slate and sandstone containing *Marshburg Upper coal*,	10′
13.	OLEAN CONGLOMERATE and sandstone with occasional slate beds,	55′

Fig. 80.

§ 237. The Clermont (Ferriferous) limestone, which in the Fourth and Fifth basins (at Clermont and elsewhere in McKean county) lies from 25′ to 40′ over the *Clermont coal*, is absent from the Sixth basin; at least I have seen nothing to represent it in any part of this basin in McKean, Elk and Forest counties.*

No limestone of any kind has been found in Lafayette township. Very few summits are geologically high enough to catch the Claremont if it existed, and these few are on the Lafayette plateau.

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* The most northern outcrop of the limestone, which has been found in the Sixth basin, is in northern Clarion county and near Tippery Corners, six miles east by south of Oil City, Venango county.

The absence of limestone and the occurrence of four distinct sandstones and conglomerates, Johnson run sandstone, Kinzua creek sandstone, Olean and sub-Olean Conglomerates, one above the other without any very great separating intervals, have been the cause of numerous errors. The distance from the top of the upper to the bottom of the lower member of this group of sand rocks is 265′; yet all the four individual members have been mistaken for one another. The correct determination of one stratum necessarily fixes the position of its associates.

Of course, this can only be the case where no great changes occur, either in the thickening of strata or in their general lithological characteristics.

§ 238. The slates, shales and sandstones overlying the *Clermont coal bed*, cap only the highest summits in the township. The soils derived from these rocks are the most fertile; but they do not differ so essentially from those derived from the disintegration of the three bottom sandstones of the coal measures, to serve as a guide to the stratigraphy. The area underlaid by these rocks is limited. They can only be found under the higher summits northeast and south-west of Alton; on the Lafayette plateau extending from the Whitman farm to the Matthews farm south-west of Lafayette and in the summit next adjoining Hamilton township, on the west.

§ 239. The *Clermont coal* bed is co-extensive with the immediately overlying slates, which form a good solid roof. As a rule, the bed seldom produces a good commercial coal, except where it is found under at least 20 to 30 feet of cover.

The average thickness of the coal varies from 3½ to 5 feet. It generally forms one solid bench, with occasionally a small slate binder toward the top. This bed has been mined on the Davis farm, where the bottom of the coal is 2141 feet above tide; on the Newell, Bullock and Root farms, where its elevation varies from 2135 to 2145 feet, and on the Whitman farm, at an elevation of 2130 feet. The same coal has also been cut through in several shafts and drill holes north-east and south-west of Lafayette.

The *Clermont coal*, like all the coal beds in the Sixth basin, is subject to many variations, affecting its value as a commercial coal producing bed.

§ 240. JOHNSON RUN SANDSTONE is the name applied to the sandstone and adjoining strata composing the interval between the Clermont coal and the Alton upper coal. It is the upper member of the Pottsville Conglomerate, No. XII; and the representative of the Homewood sandstone of Beaver, Lawrence, Butler, and Clarion counties.

On the topographical map of the Alton coal basin (Plate XII), the darkest shade (No. 1 of the color scale) represents all the strata (*Clermont over shales*, &c., *Clermont coal*, Johnson run sandstone and Alton coal group) above the top of the Kinzua creek sandstone.

The Johnson run sandstone, in this township, has a variable character. Its thickness ranges from 50′ to 60′. On the Bullock farm it is composed of a hard sandstone, with occasional bands of slate and pebbles. On the Matthew's farm its general structure is very much the same as on the Bullock farm; but on the former farm it is reported to contain, near the center, 6′ of "red rock," and near the bottom a coal bed one foot thick. Near Bond Vein, Mr. James E. Butts has pierced this interval by drill holes and a pumping shaft, and it is found to be composed entirely of black and blue slate.

At Alton it seems to be thinner than at either Lafayette or the Bullock farm. It is composed principally of slate, and contains a thin pebble sandstone near the bottom.

Most of the soil between Marshburg, Lafayette, and Alton lies directly on top of the Johnson run rock. In fact it is the top rock of three fourths of the darkest colored area on the Alton coal map (Plate XII).

§ 241. *The Alton (Mercer) coal group* contains the principal coal beds in the township. It includes three distinct coal horizons. The upper coal bed has an average thickness of two feet, and caps the series; the middle or Alton coal bed lies about twelve feet below, and is separated from the upper by blue-black slate and sandstone. The Alton coal ranges in thickness from four to seven feet, and is composed

of two or more benches of coal, separated by slate, shale, or fireclay. The interval between the middle and lower or bottom coal of the series is made up of fireclay, sandstone, and slate. Sometimes the three kinds of strata alternate, but more frequently it is all fireclay. The lower coal is extremely sporadic; it generally consists of two or three thin coal layers, alternating either with fireclay or slate, the total thickness varying from one to three feet. No limestones have ever been found which could be taken as representatives of the Mercer limestones.

The upper coal bed has been worked in the old Buttsville mine (elevation 2063 feet). It is subject to more local variations and is more treacherous to mine, than the middle or *Alton coal.* The alternating layers of slate, shale and fire clay contained in this latter bed reduces the workable coal down to about 3 feet. It has been mined extensively, at Alton and Bond Vein; and has been opened and tested in several other localities. The lowest coal of the series has never been mined; but it has been proven in a number of shafts and drill holes. I do not regard it a commercial coal.

§ 242. The KINZUA CREEK SANDSTONE like the Johnson run sandstone has a variable character within the township; as the detail description of the drill holes shows. This sandstone was not found exposed in situ any where in the township. In fact the same may be said of the Johnson run and Olean rocks. They have all been drilled through and their horizons can readily be determined by the topographical features which they form. Large loose blocks, of all the sandstones, may be found and the lithology of the strata be studied as well as if they were found in bold outcrops. Immense fragments of the Kinzua creek sandstone may be found near the summits of the hills, along the Kinzua creek valley; and it is from this fact that the rock has been named. It seems to have a more massive character in the western part of the township, than it has in the eastern or southern portion.

§ 243. The *Upper Marshburg coal* occurs in the slate and sandstone interval between the *Kinzua creek* and *Olean* rocks. The thickness of the coal has not been accurately

determined. It was opened southwest of Marshburg and a drift driven in on the bed for some distance. Here, it was reported to be 2½ feet thick. The coal is a slaty cannel and unfit for general use as a desirable fuel.

When the opening was visited it was fallen shut and the coal could not be seen. Gray slate very much stained with iron was thrown around the opening, and it was said to come from above the coal. The slate cannot be more than 5′ thick, for a small pebble conglomerate was seen but a few feet above the opening. The same coal bed was struck in the Lincoln lot drill hole, northeast of Lafayette. The drill hole on the Turner farm, west of Marshburg, went through the horizon of the *Marshburg bed*, but no coal was reported. The same may be said of the Putman drill hole southeast of Buttsville.

In the Turner drill hole, neither the *Upper or Lower Marshburg coal beds* were reported*, but within a mile of the hole, both beds have been drifted on. They are made up of poor slaty coal, and too thin and impure to be workable.

The *Upper bed* is without doubt the representative of the "splint bed" spoken of in the local geological reports.†

The *Marshburg coal beds*, although only locally deposited, seem to be well defined over a considerable area south and southeast of Marshburg.‡

§ 244. The *Olean Conglomerate*, or the bottom member of the *Pottsville Conglomerate, No. XII*, has an average thickness of about 55′.

Its character does not differ from that already described, (page 56.)

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*The *Upper bed* is above and the *Lower* bed below the *Olean conglomerate.*

†Mr. Butts, who has explored the coal areas of the township more extensively than any one else, states that he has always regarded the "splint bed" a *myth* and a *book bed* of the local geologists. Estimates have been made of the *number of tons of coal* which could profitably be mined from the *Marshburg bed.*

‡The *Lower coal* has recently been opened and mined by Mr. Gresh, in the Ridgway hill, Elk county.

Both beds have been opened on Hick's run, Cameron county.

On the Lincoln lot, the drill went through the Olean; it is reported as a gray and brown, pebbly sandstone 59′ thick.

On the Turner farm it is 56′ thick; it contains considerable blue slate interstratified with the sandstone and conglomerate beds. Here the rock is capped by a nodular iron ore, which occupies, probably the position of the *Upper Marshburg coal.*

Eight feet above the bottom of the formation, there is a fireclay bed 3′ thick, the *Olean series* is underlaid by a fireclay 5′ thick.

The *Lower Marshburg coal bed* has been opened on the Chappel fork of Kinzua creek, one mile southeast of the Turner farm. The opening is at the base of the *Olean conglomerate*, which contains numerous pebbles about the size of a pea. The elevation of the bottom of the coal is 1995′.

Midway between this opening and the Turner farm the Marshburg coal has been opened at an elevation of 2024′.

§ 245. The Sub-Olean measures are probably the same as in Bradford township.

§ 246. The *Mauch Chunk red shale*, No. XI, is not exposed anywhere, nor recognized in any of the drill holes.

§ 247. The *Pocono*, No. X, upper shales and sandstones, Sub-Olean conglomerate and lower shales and sandstones are much the same as in Bradford.

The Upper Pocono, in bore hole No. 6, on the Davis farm at Lafayette, is about 50′ thick, consisting of hard sandstone and soft slaty sandstone. The underlying 17′ of very hard, dark brown sandstone is evidently the upper part of the *Sub-Olean* but it was nowhere seen exposed at the surface, although large blocks, highly ferruginous and containing the characteristic flat pebbles, may be found near the heads of most of the ravines.

The thickness of the *upper* and *middle members* of the *Pocono* does not seem to vary very much, the latter being 30′ to 40′ thick.

The *lower* shales and sandstones thicken in a southern direction. At Lewis run they measure 160′, while on Kinzua creek they are at least 250′ thick.

The local explorations and coal workings, in the town-

ship, have been so scattered that it is hardly possible to group the descriptions, either on a stratigraphical, geographical or economical basis.

The arrangement, which has been adopted, seems most natural, commencing at Bond vein, thence to Buttsville, thence to Alton, to Lafayette and vicinity, thence to the Whitman farm, and finally the Marshburg plateau from Lafayette northwest to the Turner farm.

§ 248. *Bond Vein.*—The Longwood Coal Company's mine at Bond Vein, operated by Mr. James E. Butts, has been longer and more continuously worked than any coal mine in the township. The bed which is mined is what I have called the Alton coal, or the middle bed of the Alton group. The mine mouth is on the west side of the railroad, and the elevation of the bottom of the coal at this point is 2034 feet above tide.

The section of the bed, measured in what is known as the Rush entry is as follows: (Fig. 81.)

1. Slate roof,	good.
2. Coal,	1′ 9″
3. Slate (2″ to 11″),	2″
4. Coal,	1′
5. Slate and coal,	8″
6. Sandstone,	1 4″
7. Coal,	1′ 6′
8. Fireclay,	—

The dip of the coal bed in this entry is about 3° in a direction south 15° west. This is much greater than the average dip of the coal, and is evidently due to a local roll. In the Maloney drift, which is in the same mine, but at some distance from the Rush entry, the section of the coal shows considerable variation. Both the character of the roof and floor of the mine has changed: (Fig. 84.)

1. Rock roof,	good.
2. Coal (bony),	6″ to 8″
3. Coal,	1′ 9″
4. Fireclay,	9″
5. Soft coal,	1′ 5″
6. Black slate,	6″
7. Coal,	1′ 2″
8. Hard sandy fireclay,	1′ to 1′ 6″
Coarse white sandstone,	—

The black slate between the bottom and middle benches of coal varies in thickness from 2″ to 14″, and oftentimes changes from slate to fireclay. The change takes place gradually, and most generally on top of a "roll" in the coal bed.

The coal bed in the Bond Vein mine is invariably a three bench coal. An average section would be: (Fig. 85.)

1. Slate roof,	—
2. Coal,	2′
3. Separation,	8″
4. Coal,	1′ 2″
5. Separation,	1′
6. Coal,	1′
7. Fireclay,	—

This section would show about four feet of coal which it is possible to mine; the total thickness of the bed being about six feet.

The coal from the top bench is very compact and brittle; luster generally resinous, with thin seams of bright crystalline coal running through the mass; shows considerable slate partings.

On analysis the coal showed (A. S. McCreath):

Water @ 225°,	.670
Volatile matter,	36.065
Fixed carbon,	48.417
Sulphur,	1.058
Ashes,	13.790
	100.000
Coke, per cent.,	63.265
Color of ash,	gray.
Fuel ratio,	1:1.34

The coal from the middle bench is compact and brittle; generally like that from the upper bench, but carries fewer slate partings and consequently gives much less ash in the analysis, which is as follows (A. S. McCreath):

Water, @ 225°,	1.030
Volatile matter,	37.630
Fixed carbon,	51.237
Sulphur,	1.553
Ash,	8.550
	100.000
Coke, per cent.,	62.370
Color of ash,	gray.
Fuel ratio,	1:1.36

The lower bench coal is also compact and brittle, and besides carrying numerous slate partings, shows considerable pyrites. On analysis it gave (A. S. McCreath):

Water, @ 2250,	.710
Volatile matter,	32.980
Fixed carbon,	46.867
Sulphur,	2.943
Ash,	16.500
	100.000
Coke per cent.,	66.310
Color of ash,	gray, red tinge.
Fuel ratio,	1:1.42

The poorest coal from the mine is taken from the lowest bench.

Of course, all three benches are mined together, and the mixed product is the market coal of the Bond Vein mine.

An average analysis of the coal as it is shipped on the cars would be represented as follows:

Water, @ 225°,	.803
Volatile matter,	35.558
Fixed carbon,	48.840
Sulphur,	1.852
Ash,	12.947
	100.000

Unfortunately the dip of the coal is such that the mine has to be pumped. In a north-west direction from Bond Vein to Alton the bed dips at an average rate of about one foot to the hundred. The north-west dip to the left of the main entry is less than it is to the right. The maximum dip in the mine seems to be nearly west. The coal is subject to so many local dips that it is practically impossible to make a general statement that would apply to any considerable area.

The accompanying section is constructed from the record of a drill hole (Bob Johnson No. 1) several hundred feet west (?) of the mouth of the mine: (Fig. 88.)

1. Detritus,	10′	to 10′
2. Black slate,	23′	to 33′
3. Hard blue slate,	1′	to 34′
4. Blue slate,	30′ 6″	to 64′ 6″
5. Coal (Upper bed Alton group),	8″	to 65′ 2″
6. Blue slate,	10′	to 75′ 2″

7. Black slate,		6″	to 75′ 8″
8. Coal,	Alton coal bed,	2′	to 77′ 8″
9. Coal,	Alton coal bed,	1′	to 78′ 8″
10. Coal,	Alton coal bed,	3′	to 81′ 8″
11. Fireclay,		1′ 3″	to 82′ 11″

The character of the strata above the upper coal of the Alton group is unusual. They represent the interval of the Johnson run sandstone which at Buttsville, but one mile distant, is filled by sandstone.

The eight inch coal which is shown in the section 10½ feet above the Alton coal is extremely sporadic, in the vicinity of Bond Vein. In several places where the roof of the mine was pierced it was not found. On account of the uncertainty of its occurrence the miners frequently call it the "thief vein." It is the representative of the bed which was worked at the old Buttsville mine.

The following section is constructed from the record of a drill hole which was bored by Mr. Alton, in the vicinity of Bond Vein. The record was obtained from Mr. Butts, but the location of the hole was not determined. It is quite probable that the upper part of the section represents the Kinzua creek sandstone; the three small coal beds occurring respectively at the depth of 37′, 42′ 8″ and 46′ 6″, represent the Marshburg coal bed, and the lower 19 feet the upper part of the OLEAN CONGLOMERATE. (Fig. 90.)

1. Detritus,	7′ 6″	to 7′ 6″
2. Sandy shale,	3′	to 10′ 6″
3. Pebbly SS.,	8′	to 18′ 6″
4. Red SS.,	4′ 2″	to 22′ 8″
5. Pebbly SS.,	6′	to 28′ 8″
6. Brown SS.,	3′	to 31′ 8″
7. Blue slate,	2′ 6″	to 34′ 2″
8. Brown SS.,	2′ 10″	to 37′
9. *Coal*,	4″	to 37′ 4″
10. Brown SS.,	1′ 10″	to 39′ 2″
11. Pebbly SS.,	2′	to 41′ 2″
12. Brown SS.,	1′ 6″	to 42′ 8″
13. *Coal*,	2″	to 42′ 10″
14. Blue slate,	9″	to 43′ 7″
15. Pebbly SS.,	2′ 11″	to 46′ 6″
16. *Coal*,	4″	to 46′ 10″
17. Pebbly SS.,	2′	to 48′ 10″
18. White SS.,	3′ 2″	to 52′
19. Blue shale,	6″	to 52′ 6″

20. Pebbly SS.,	6″	to	53′
White SS.,	13	to	66′

Near the south-west corner of the Lafayette Coal Company's lands and on a line about midway between Bond Vein and the Owen mine at Buttsville, a hole was drilled to the depth of 70 feet. The exact location of the hole was not determined and its elevation was not obtained. I am therefore unable to state authoritatively the exact position in the coal series of the strata pierced. There is every reason to believe, however, that the small coal seams struck at a depth of 25 feet and 28 feet 7 inches are the representatives of the upper coal of the Alton group. In this case the Alton bed would be absent from the section. This interpretation seems not at all improbable, when we remember that Mr. Butts has failed to find the Alton bed in the vicinity of Buttsville.

The following is the record: (Fig. 92.)

1. Detritus,	4′	to 4′
2. Fireclay,	4′	to 8′
3. Dark blue slate,	14′	to 22′
4. Brown SS.,	3′	to 25′
5. *Coal*,	4″	to 25′ 4″
6. Fireclay,	9″	to 26′ 1″
7. Dark brown SS.,	2′ 6′	to 28′ 7″
8. *Coal*,	2″	to 28′ 9″
9. Dark blue slate,	25′	to 53′ 9″
10. Fireclay,	3′	to 56′ 9″
11. Blue slate,	8′	to 64′ 9″
12. Light brown SS.,	3′	to 67′ 9″

The 3-foot bed of fireclay struck at a depth of 53 feet 9 inches may be the under clay of the *Alton coal bed*.

§ 249. *Buttsville.*—The old Owen or Buttsville mine is located some 800 feet south of Mr. James E. Butts' house. The opening was originally made by Mr. Owen. The Longwood Coal Company commenced mining operations in April, 1867. The floor of the drift at the mouth of the mine is 2065 feet above sea level When the mine was visited in 1876 the drift had "fallen shut" and the face of the coal was not seen. The bed was reported to be composed of one solid bench of coal with an average thickness of 2½ feet. The roof is composed of slate and the floor of fire clay.

The bed is the representative of the upper coal of the Alton group. On account of the local irregularities which were found to exist in the bed the development proved an expensive one. The mine was finally abandoned on account of the coal thinning out.

The Alton coal bed has never been opened in the immediate vicinity of the Owen mine. A hole was drilled in front of Mr. Butts' house to a depth of 28 feet and a seam of coal 2 feet thick was reported, near the bottom of the hole. This coal was taken to be the Alton bed but it seems to lie too low; it is in all probability the lowest coal of the Alton group. The Alton or middle bed of the group has been opened in the Seven Foot knoll directly southeast of the Owen mine, and it would seem reasonable to expect to find it under the Owen opening. When we take into consideration the great change which the Johnson run rock undergoes between Buttsville and Bond Vein, we can readily imagine a change in the structure of the Alton group which should permit the Alton coal bed to be found at Bond Vein and the Seven Foot knoll and not at Buttsville. These changes in the stratigraphy of the coal measures argue against the economical importance of the Alton coal basin.

§ 250. *Seven Foot knoll.*—The extreme southeastern portion of the Alton basin in Lafayette township has been very thoroughly explored.

In the Seven Foot knoll which lies partly in Lafayette and partly in Keating township the Alton coal bed has been drifted on and numerous holes have been drilled through the underlying strata to a depth below the coal of 72 feet.

The elevation of the floor of the mine at its mouth is 2053 feet. The average thickness of the coal bed including the slate partings has been considered to be "seven feet," and this fact has given the name to the knoll. Immediately above the opening a shaft was sunk to the bottom of the Alton bed and the following record was reported: (Fig. 85.)

1. Detritus,	3′ 6″ to	3′ 6″
2. Fireclay,	1′ 3″ to	4′ 9″
3. Nodular iron ore,	1′ 3″ to	6′
4. *Coal*,	2′ 4″ to	8′ 4′
5. Fireclay,	8″ to	9′

Alton Middle Coal bed.

Fig. 81. p. 195.
Rush entry Bond Vein.

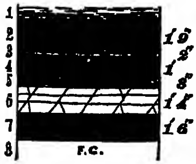


Fig. 84. p. 195.
Maloney drift Bond Vein.

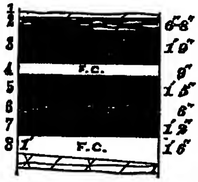


Fig. 83, page 202 represents an average section of the coal in the Bond Vein mine.

Fig. 82. p. 202.
Shaft No. 1.
Seven Foot Knoll.

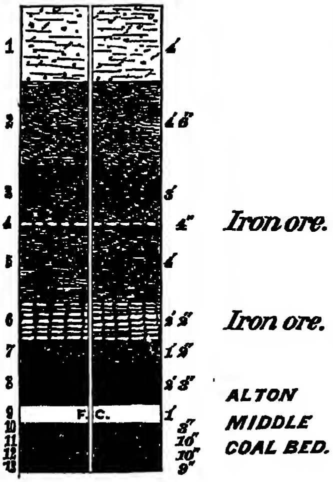
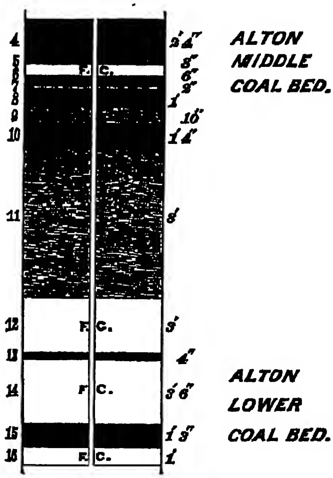


Fig. 85. p. 204.
Drill hole. Seven Foot Knoll.



Average Sections A. M. coal.

Fig. 83. p. 202.
Bond Vein Mine.

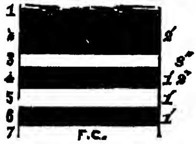


Fig. 86. p. 202.
Seven Foot Knoll.

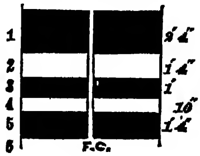
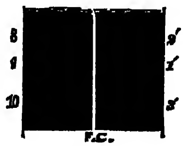


Fig. 87. p. 198.
Alton Middle Coal bed.
Drill hole Bob Johnson No. 1.



6. *Coal*,		6″ to 9′ 6″
7. Slate,		2″ to 9′ 8″
8. *Coal*,	1′	to 10′ 8″
9. Slate,		10″ to 11′ 6″
10. *Coal*,	1′	4″ to 12′ 10″

The top of the hole is below the upper or Buttsville bed. In fact the knoll is too low to take in this coal. The total thickness of the bed as cut by the shaft is 6 feet 10 inches.

The general character of the section of the coal is not unlike that at the Bond Vein mine. The two sections are given below and the comparison is striking: (Figs. 83 and 86.)

	Bond Vein.	*Seven Foot knoll.*
1. Coal,	2′	2 4″
2. Separation,	8′	1′ 4″
3. Coal,	1 2	1′
4. Separation,	1′	10″
5. Coal,	1′	1′ 4″
6. Fireclay,	5′ 10″	6′ 10″

The total thickness is 1 foot greater at the Seven Foot knoll. The upper separation is 8 inches thicker and contains a coal seam 6 inches thick.

The coal is overlaid by a thin bed of "ball ore" carbonate of iron. This feature is quite characteristic of the Alton coal bed throughout the county and is one of the best guides to the correct identification of this part of the coal measures.

Immediately on top of the knoll which is 2083 feet above tide a shaft* was sunk and the record reported was as follows: (Fig. 82.)

Shaft No. 1.

1. Detritus,	4′	to 4′
2. Brown shale,	4′ 6″	to 8′ 6″
3. Blue slate,	3′	to 11′ 6″
4. Nodular iron ore,	4″	to 11′ 10″
5. Blue slate,	4′	to 15′ 10″
6. Nodular iron ore,	2′ 2″	to 18′
7. Black slate,	1′ 2″	to 19′ 2″
8. *Coal*,	2′ 3″	to 21′ 5″
9. Fireclay,	1′	to 22′ 5″
10. Slate,	3″	to 22′ 8″

*This shaft was started on the highest point of the knoll which is 270 feet southwest of the mouth of the drift.

Fig. 88. p. 197.

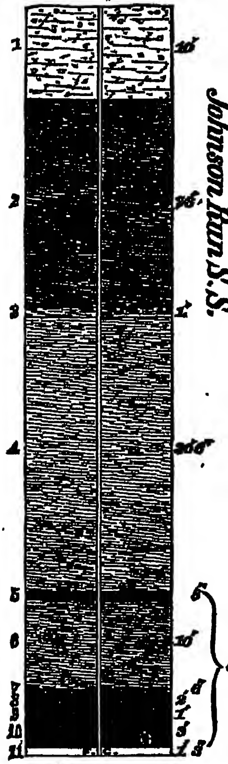


Fig. 90. p. 198. *Bond Vein.*

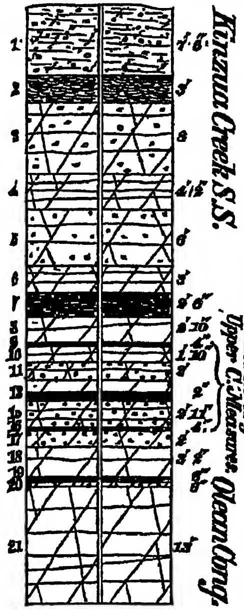


Fig. 92. p. 199. *Lafayette C. Co.*

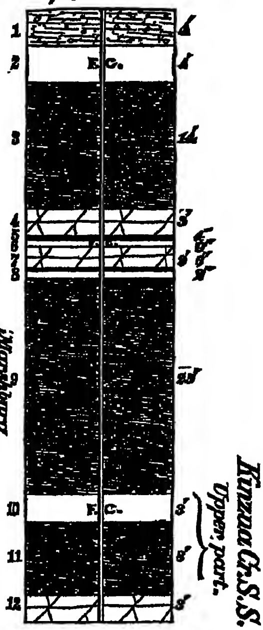


Fig. 89. p. 210.

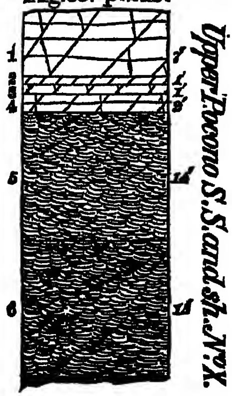


Fig. 91. p. 209. *Three Mile Run.*

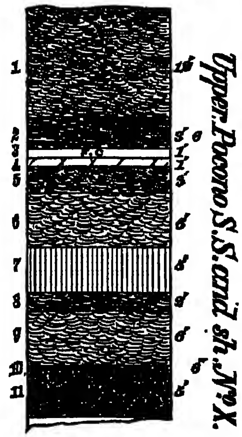
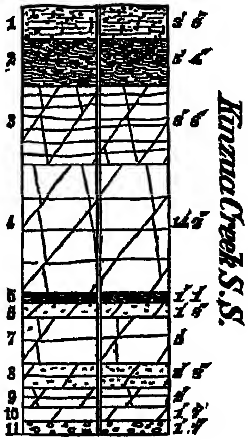


Fig. 93. p. 208. *Seven Foot knoll.*



11. *Coal*,	10″	to 23′ 6″
12. *Coal* and slate mixed,	10″	to 24′ 4″
13. Coal,	9″	to 25′ 1″

The section of the *Alton bed* in the shaft is somewhat different from that given above near the mouth of the drift. The variation is no greater than that which is often found to exist in the mine at Bond Vein.

A drill hole was bored in the immediate vicinity of Shaft No. 1 and the strata, to within a few feet of *Marshburg coal horizon* were pierced as follows: (Fig. 99.)

1. Detritus,		3′ 6″	to 3′ 6″
2. Fireclay,		1′ 3″	to 4′ 9″
3. Nodular iron ore,		1′ 3″	to 6′
4. Coal,	Alton coal bed,	2′ 4″	to 8′ 4″
5. Fireclay,	Alton coal bed,	8″	to 9′
6. Coal,	Alton coal bed,	6″	to 9′ 6″
7. Slate,	Alton coal bed,	2″	to 9′ 8″
8. Coal,	Alton coal bed,	1′	to 10′ 8″
9. Slate,	Alton coal bed,	10″	to 11′ 6″
10. Coal,	Alton coal bed,	1′ 4″	to 12′ 10″
11. Black slate,		8′	to 20′ 10″
12. Fireclay,		3′	to 23′ 10″
13. Coal,	Lower coal, Alton group,	4″	to 24′ 2″
14. Fireclay,	Lower coal, Alton group,	3′ 6″	to 27′ 8′
15. Coal,	Lower coal, Alton group,	1′ 3″	to 28′ 11″
16. Fireclay,		1′	to 29′ 11″
17. White SS.,		6′ 6″	to 36′ 5″
18. Dark blue slate,		3′ 9″	to 40′ 2″
19. Indurated fireclay,		3′ 9″	to 43′ 11″
20. Brown and olive, compact SS.,		41′	to 84′ 11″

No pebbles were encountered in the KINZUA CREEK SANDSTONE.

Seven hundred feet more or less northeast of shaft No. 1 a second shaft was dug to a depth of 21 feet. The elevation of the top of the shaft is 2060 feet and the record of the strata as follows: (Fig. 96.)

Shaft No. 2.

1. Detritus,	8′	to 8′
2. Brown shale,	7′	to 15′
3. *Coal*,	1′	to 16′
4. Black slate,	6″	to 16′ 6″
5. *Coal*,	4″	to 16′ 10″
6. Fireclay,	2′ 6″	to 19′ 4″
7. *Coal*,	1′	to 20′ 4″
8. Brown SS.,	6″	to 20′ 10″
Olive shales,	—	

Fig. 94. p. 206.
Shaft No. 3.
Seven Foot Knoll.

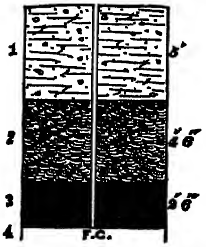
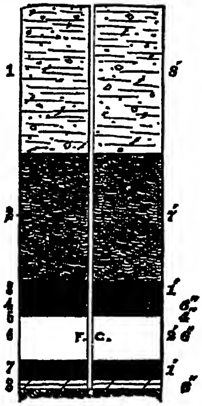
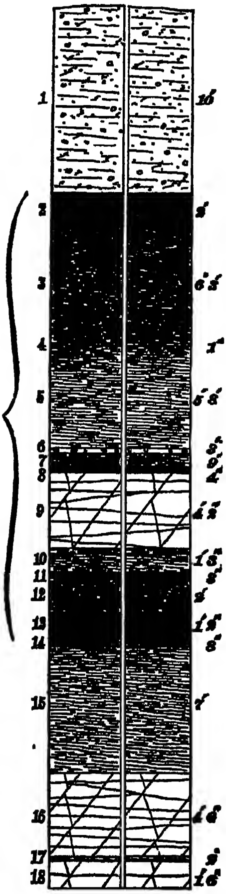


Fig. 96. p. 204.
Shaft No. 2.
Seven Foot Knoll.



ALTON MIDDLE COAL BED.

Fig. 98. p. 214.
Alton's Log-house drill hole.



Alton Coal Group 24+ feet.

Fig. 95. p. 206.
Drill hole
Seven Foot Knoll.

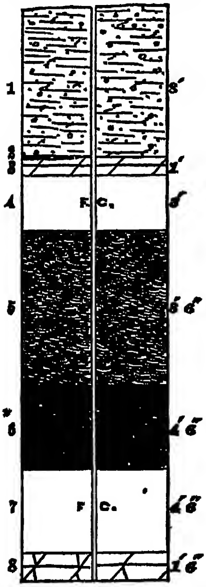
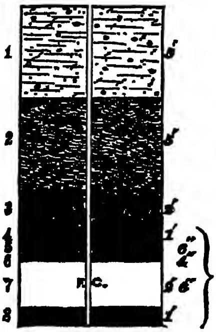


Fig. 97. p. 206.
Shaft No. 4.
Seven Foot Knoll.



OUTCROP COAL.

At this point the fireclay which is invariably found underneath the bottom coal bench is replaced by brown sandstone and olive shales. The coal is also somewhat thinner but that is possibly due to the fact of its being near the outcrop.

In shaft No. 3 which is 600 feet north 30 degrees east of No. 1 the following section was obtained: (Fig. 94.)

1. Detritus,	5′	to 5′
2. Brown and red shale,	4′ 6″	to 9′ 6″
3. Coal,	2′ 6″	to 12′
4. Fireclay,	—	—

The fourth shaft was sunk to the Alton bed near its outcrop and at a point 280 feet east of shaft No. 3. Both of these shafts are too near the outcrop of the coal bed to give a reliable statement of its thickness: (Fig. 97.)

Shaft No. 4.

1. Detritus,	5′	to 5′
2. Red and brown shale,	5′	to 10′
3. Black slate,	2′	to 12′
4. Coal,	1′	to 13′
5. Slate,	6″	to 13′ 6″
6. Coal,	4″	to 13′ 10″
7. Fireclay,	1′ 6″	to 16′ 4″
8. Coal,	1′	to 17′ 4″

Thirty rods (481.5 feet) east of shaft No. 1 a hole was drilled to a depth of 31 feet and the following record of the strata procured: (Fig. 95.)

1. Detritus,	8′	to 8′
2. Coal streak, } 3. Black rock, }	1′	to 9′
4. Fireclay,	3′	to 12′
5. Brown and olive shales,	8′ 6″	to 20′ 6″
6. Black slate mixed with coal,	4′ 6″	to 25′
7. Fireclay,	4′ 6″	to 29′ 6″
8. White SS.,	1′ 6″	to 31′

The top coal struck in this hole is the *Alton bed* and the coal which was found mixed with black slate 11½ feet below it, is the representative of the lower coal of the Alton group. At no locality in the township has this coal been found of workable dimensions, a great deal of slate is invariably associated with it which depreciates its quality to such an

Fig. 99. p. 204.
Seven Foot Knoll.

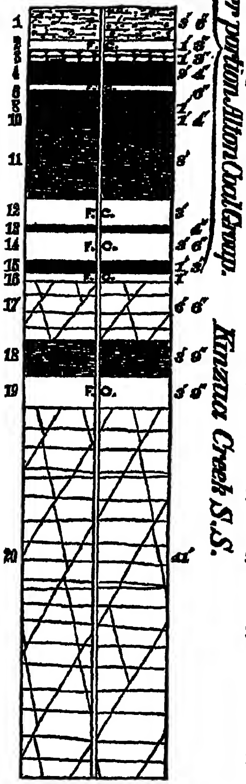


Fig. 101. p. 209.
Putman Drill hole.
Typical Section of the Pottsville Conglomerate No. XII

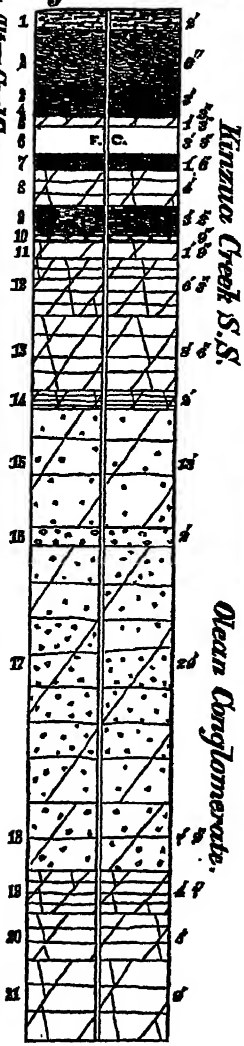
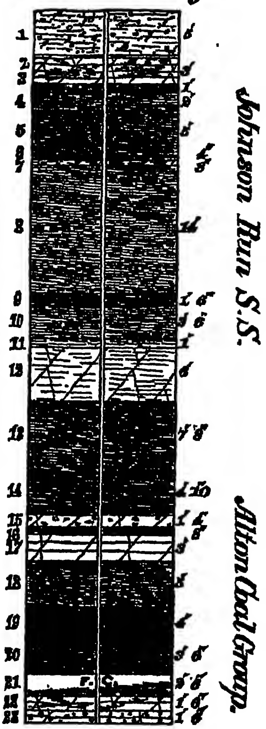


Fig. 102. p. 211.
M. Alton's boring S.



Sections figs. 89 and 91 page 203 represent the strata immediately below Section fig. 101 and above the Sub-Olean Cong.

The Johnson Run Sandstone is locally changed in character in the vicinity of Alton and Bond Vein, as shown in Section fig. 102.

extent that the coal may be said to be of no economical importance.

A second drill hole was bored through the KINZUA CREEK SANDSTONE at a point 275 feet south 60 degrees east of shaft No. 1. The record is as follows: (Fig. 93.)

1. Detritus,	3′ 6″	to	3′ 6″
2. Brown and olive shale,	5′ 4″	to	8′ 10″
3. Fine white SS.,	8′ 8″	to	17′ 6″
4. Compact brown SS.,	14′ 2″	to	31′ 8″
5. Black marly shale,	1′ 1″	to	32′ 9″
6. White quartzose SS.,	1′ 8″	to	34′ 5′
7. Compact gray SS.,	5′	to	39′ 5″
8. White quartzose SS.,	2 8″	to	42′ 1″
9. Bluish gray SS.,	2′	to	44′ 1″
10. Brown SS.,	1′ 7″	to	45′ 8″
11. Coarse conglomerate,	1′ 7″	to	47′ 3′

The strata pierced in this hole occupy the same geological horizon as those drilled through in the hole in the vicinity of shaft No. 1, (page 204.) The character of the rocks is very much the same at both places. The sections give one an admirable idea of the middle sandstone member of the Pottsville Conglomerate No. XII. The dips of the strata under the Seven Foot knoll vary very much and are subject to many local rolls.

The elevation of the Alton bed, at the Seven Foot opening, is about the same as the estimated elevation of the geological horizon of the same bed at Buttsville, so that, except for local rolls the strata would lie perfectly horizontal between the two localities.

§ 251. *Putman drill hole.*—Eighty rods (1284 feet) east of Mr. Butt's saw-mill on Three Mile run, Mr. Allen Putman, of Boston, had a hole drilled through the rocks to a depth of 113 feet 6 inches. It was thought that the drill would intersect several valuable coal beds among which was thought to be the "Splint bed." In reality the top of the hole which is at an elevation of 2037 feet is just below the horizon of the Alton bed which we have found to be the lowest bed of the coal measures which could be *profitably* mined.

The two small coal seams struck at a depth of 11 and 16 feet respectively with the included sandstone and fireclay represent the lowest coal of the Alton group. The drill

went through the entire thickness of the Kinzua creek sandstone and a greater portion of the Olean Conglomerate. From the record I am unable to detect the horizon of the Marshburg coal.

The section is as follows: (Fig. 101.)

1. Detritus,	2′	to	2′
2. Broken brown shale,	6′	to	8′
3. Blue slate,	3′	to	11′
4. *Coal*,	3″	to	11′ 3″
5. White SS.,	1′ 3″	to	12′ 6″
6. Fireclay,	3′ 3″	to	15′ 9″
7. Slate and *coal* mixed,	1′ 6″	to	17′ 3″
8. Light brown SS.,	4′	to	21′ 3″
9. Dark blue slate,	3′ 3″	to	24′ 6″
10. Nodular iron ore,	9″	to	25′ 3″
11. Gray SS.,	1′ 9″	to	27′
12. Dark brown SS.,	6′ 3″	to	33′ 3″
13. Light brown SS.,	8′ 6″	to	41′ 9″
14. Gray SS.,	2′	to	43′ 9″
15. Coarse brown pebble rock,	13′	to	56′ 9″
16. Very dark coarse pebble rock,	2′	to	58′ 9″
17. Fine brown pebble rock,	29′	to	87′ 9″
18. Very dark pebble rock,	7′ 2″	to	94′ 11″
19. White SS.,	4′ 7″	to	99′ 6″
20. Light brown SS.,	5′	to	104′ 6″
21. Dark brown SS.,	9′	to	113′ 6″

The position of this hole was determined through spiritual influences which in *this particular* failed as a reliable guide.

§ 252. A short distance below the saw-mill on Three Mile run Mr. Butts made a side cutting on the west bank of the run and exposed the following section: (Fig. 91.)

1. Light brown shales,	12′
2. Blue slate,	3′ 6″
3. Dark blue indurated fireclay,	1′
4. Dark brown SS.,	1′
5. Ferruginous shales,	3′
6. Light brown shales,	6′
7. *Limestone fossiliferous*,	5′
8. Dark brown shales,	2′
9. Light brown shales,	6′
10. Green shales,	6″
11. Smut with *coaly* particles,	5′

The elevation of the top of the section is 1928 feet above tide. The strata described are those lying between the

OLEAN and SUB-OLEAN CONGLOMERATES. The top of this cut is just about at the bottom of the former conglomerate.

Twenty-six feet and a half from the top of the section a fossiliferous limestone is reported. When I visited the cutting several years after it had been made every thing was covered up and I was unable to see any traces of a limestone, but Mr. Butts assures me that the stratum noted "fossiliferous limestone" was a genuine limestone bed but rather impure from containing a great deal of silicious matter, which rendered the stone very hard. A careful search was made for this limestone everywhere in the county but no where was such a bed found between the conglomerates.

It was very important to determine whether there was to be found a persistent bed of limestone in this part of the series. If such had been discovered it would have been very reasonable to assert that it was the representative of the mountain limestone of No. XI. The evidence as gathered from this section is too meagre to accept the conclusion that this "fossiliferous limestone" is really in No. XI. I see no facts here to invalidate in any way my description of the MAUCH CHUNK series already given (page 63).

On the same bank of the creek and some 350 feet further down the stream a second side cut was made and the following strata exposed: (Fig. 89.)

1. Brown friable SS.,	7′
2. Compact dark brown SS.,	1′
3. Black and gray SS.,	1′
4. Dark brown SS.,	2′
5. Light brown shales,	14′
6. Dark brown shales,	15′
Smut with *coaly* particles,	—

The elevation of the top of the section is 1907 feet above tide.

The strata occupy the same geological position between the two conglomerates as those described in the former cut. It will be noticed in both sections that "coaly particles" are mentioned as found at the bottom of the cuts. If it was not for the fact that the stratigraphical position of each of these cuts is far below the place where any coal has ever been found in McKean county, I should regard the mention

of "coaly particles" of some significance. I cannot believe that coal could have been found in these localities and the record of the fact well illustrates the tendency of human nature, as too frequently developed in the average prospector, and that is to finish work in such a stratum as to encourage their employers to make further explorations.

§ 253. *Alton.*—The Lafayette Coal Co. about 1865 planned quite an extensive mine plant to develop the Alton coal bed at Alton. After several years operations the works were finally abandoned. The mine was entered by a slope which descended 92 feet vertically; its length being 280 feet. The following section is constructed from the record of a drill hole bored in the vicinity of the slope (Fig. 102):

1. Detritus,	5′	to 5′
2. Shaly SS.,	3′	to 8′
3. Black slate and *coal,*	1′	to 9′
4. Light slate,	2′	to 11′
5. Dark slate,	5′	to 16′
6. Black slate,	4″	to 16′ 4″
7. Slate rock,	8″	to 17′
8. Blue slate,	14′	to 31′
9. Black slate,	1′ 6″	to 32′ 6″
10. Blue slate,	3′ 6″	to 36′
11. Blue SS.,	1′	to 37′
12. Slate rock,	6′	to 43′
13. Dark slate,	7′ 8″	to 50′ 8″
14. Very dark slate,	4′ 10″	to 55′ 6″
15. Pebbly SS.,	1′ 4″	to 56′ 10″
16. Black slate,	8″	to 57′ 6″
17. Hard blue SS.,	3′	to 60′ 6″
18. Blue slate,	5′	to 65′ 6″
19. *Coal,* (cannel and bituminous mixed),	4′	to 69′ 6″
20. *Coal,* and slate,	3′ 6″	to 73′
21. Fireclay and slate,	2′ 6″	to 75′ 6″
22. Shaly SS.,	1′ 6″	to 77′
23. Pebbly SS.,	1′ 6″	to 78′ 6″

The foot of black slate and coal which was struck at a depth of 8 feet may represent the Clermont coal bed which is opened at the Davis mine near Lafayette. The interval between this coal and the Alton bed is not as great as the interval between the Clermont and Alton beds at Lafayette, so that this thin seam may be a sporadic bed in the upper part of the Johnson run sandstone interval. As at Bond Vein this sandstone is replaced by slate. The section of

the Alton bed varies but little from that given of the bed at Bond Vein. Some two years ago Mr. Butts had driven his workings into the old Alton mine.

Near the west line of the Lafayette Coal Company's lands next adjoining the Hardie farm and 80 rods (1284 feet) south of the county road running from Alton to Lafayette, a hole was drilled to a depth of 88 feet.

The elevation of the top of the hole is 2159 feet above tide and the following is the record (Fig. 103):

1. Detritus,	5′	to 5′
2. Blue slate,	10′	to 15′
3. Smut,	1′	to 16′
4. Blue slate,	16′ 6″	to 32′ 6″
5. Nodular ore,	3′	to 35′ 6″
6. Black slate,	2′ 6″	to 38′
7. Nodular ore,	1′ 6″	to 39′ 6″
8. Fireclay,	3′	to 42′ 6″
9. Blue SS.,	1′ 6″	to 44′
10. Coal (*Alton Upper bed*),	9″	to 44′ 9″
11. Gray SS.,	2′ 3″	to 47′
12. Fireclay,	6″	to 47′ 6″
13. Black slate,	12′	to 59′ 6″
14. Fireclay,	1′ 9″	to 61′ 3″
15. Blue slate,	1′ 3″	to 62′ 6″
16. Fireclay, indurated,	4′ 9″	to 67′ 3″
17. *Coal*,	10″	to 68′ 1″
18. Fireclay,	1′ 2″	to 69′ 3″
19. *Coal*,	6″	to 69′ 9″
20. Dark gray SS.,	15′ 7″	to 85′ 4″
21. Black slate,	4″	to 85′ 8″
22. Blue slate,	1′ 4″	to 87′
23. *Coal* and slate, mixed,	6″	to 87′ 6″
24. Shale rock,	2″	to 87′ 8″
25. Cannel coal,	2″	to 87′ 10″
26. White SS.,	5″	to 88′ 3″

The drill went through the lower part of the Johnson run sandstone which is represented by blue and black slate with nodular iron ore in the lower part.

The upper coal bed of the Alton group was struck at a depth of 44 feet and is reported 9 inches thick. The lower coal found at a depth of 67 feet 3 inches is possibly the representative of the Alton bed.

Near Mr. Alton's old log house about half a mile west of the railroad station a hole was drilled to a depth of 48 feet and gives an admirable section of the Alton coal group,

Fig. 103. p. 212.

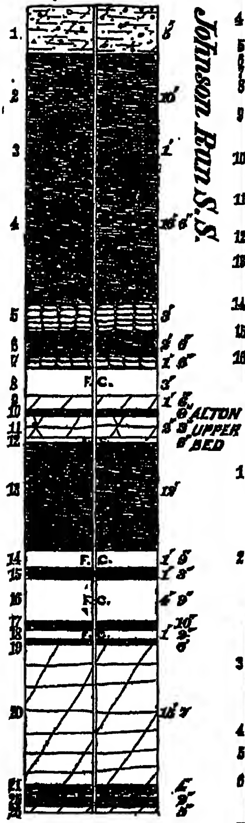


Fig. 104. contin'd

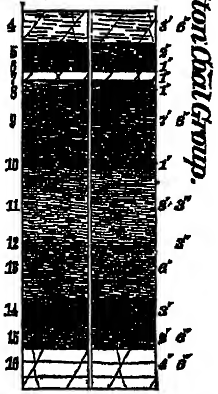


Fig. 105. p. 215.

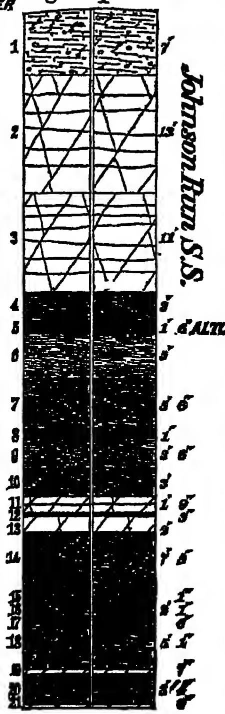


Fig. 106. p. 216.
Armstrong lot.

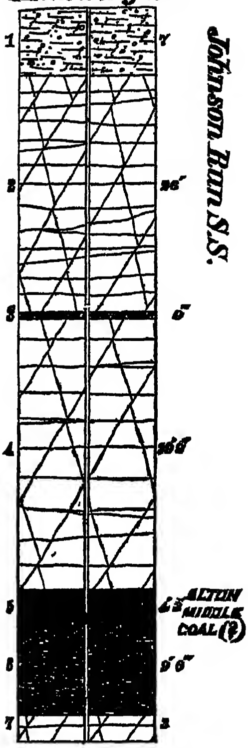


Fig. 107. p. 228.
Newell farm.

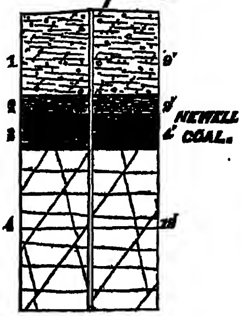
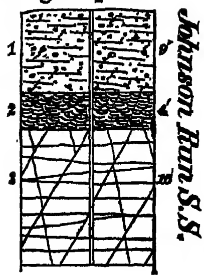


Fig. 104. p. 214.



possibly the best of which we have any record. I was unable to determine the exact location of the hole so that its elevation was not obtained.

The following is the record as reported (Fig. 98):

	1 Detritus,	10′	to 10′
Alton coal group.	2. C[illegible],	2′	to 12′
	3. Dark slate,	6′ 3″	to 18′ 3″
	4. Iron ore,	1″	to 18′ 4″
	5. Slate,	5′ 8″	to 24′
	6. White pebble rock,	3″	to 24′ 3″
	7. Slate,	9″	to 25′
	8. *Coal,*	4″	to 25′ 4″
	9. White SS.,	4′ 2″	to 29′ 6″
	10. Light slate,	1′ 3″	to 30′ 9″
	11. *Coal,*	3″	to 31′
	12. Black slate,	2′	to 33′
	13. *Coal,*	1′ 2″	to 34′ 2″
	14. Dark slate,	8″	to 34′ 10″
	15. Slate,	7′	to 41′ 10″
	16. Blue SS.,	4′ 6″	to 46′ 4″
	17. Iron ore,	2″	to 46′ 6″
	18. White SS.,	1′ 6″	to 48′

Four additional records were obtained from Mr. Butts of holes which had been drilled in the vicinity of Alton under the supervision of Mr. Alton. Their location was not known and the sections are reproduced here as copied from the original records.

Boring V, Lafayette Coal Company's land vicinity of Alton (Fig. 108).

1. Detritus,	7′	to 7′
2. *Cannel coal,*	1′ 8″	to 8′ 8″
3. Fireclay,	2′	to 10′ 8″
4. Shale,	—	—

Boring W (Fig. 110).

1. Detritus,	5′ 6″	to 5′ 6″
2. Slate,	13′ 7″	to 19′ 1″
3. *Coal,*	11″	to 20′
4. Fireclay,	1′ 6″	to 21′ 6″

Boring P (Fig. 104).

1. Detritus,	9′	to 9′
2. Sandy shale,	4′	to 13′
3. White SS.,	16′	to 29′
4. Light slate rock,	3′ 6″	to 32′ 6″

5. Black slate,	2′	to 34′ 6″
6. *Coal,*	1′	to 35′ 6″
7. SS.,	1′	to 36′ 6″
8. Slate,	1′	to 37′ 6″
9. Black slate,	7′ 6″	to 45′
10. *Coal,*	1′	to 46′
11. Light slate,	8′ 3″	to 54′ 3″
12. Black iron ore,	3″	to 54′ 6″
13. Slate,	6′	to 56′ 6″
14. *Coal,*	3′	to 63′ 6″
15. Slate,	2′ 6″	to 66′
16. White SS.,	4′ 6″	to 70′ 6″

This drill hole went through the Alton coal group and shows a stratification not unlike that found near Mr. Alton's old log-house.

Boring Q (Fig. 105).

1. Detritus,	7′	to 7′
2. Brown SS.,	13′	to 20′
3. White SS.,	11′	to 31′
4. Black slate,	3′	to 34′
5. *Coal,*	1′ 6″	to 35′ 6″
6. Light slate,	5′	to 40′ 6″
7. Dark slate,	5′ 6″	to 46′
8. *Coal,*	1′	to 47′
9. Light slate,	3′ 6″	to 50′ 6″
10. Dark slate,	3′	to 53′ 6″
11. White SS.,	1′ 9″	to 55′ 3″
12. *Coal,*	3″	to 55′ 6″
13. White SS.,	2′	to 57′ 6″
14. Dark slate,	7′ 3″	to 64′ 9″
15. Iron ore,	1″	to 64′ 10″
16. Dark slate,	2′ 1″	to 66′ 11″
17. *Coal,*	6″	to 67′ 5″
18. Slate,	5′ 1″	to 72′ 6″
19. SS.,	7″	to 73′ 1″
20. Slate,	3′ 4″	to 76′ 5″
21. Blue SS.,	6″	to 76′ 11″

These four sections can no doubt be located by those in possession of the original maps of the Lafayette Coal Company. The records have no doubt been faithfully kept, and it is important to place them in a permanent form for preservation.

§ 254. *Hagadorn farm.*—A hole was drilled on this farm, which is located east of Lafayette, to a depth of 21 feet.

The following record was reported (Fig. 112):

1. Detritus,	10′	to 10′
2. Soft shale rock,	5′ 6″	to 15′ 6″
3. Shale and coal,	5′ 6″	to 21′

The position of this hole is not known, so that it is impossible to name the coal which was found at the bottom where the drilling was stopped.

On this same farm and some distance south of the county road a fireclay bed has been opened and worked, and is said to produce a clay admirably adapted to the manufacture of a good grade of pottery.

A shaft 24 feet deep was dug to the clay bed. The following is a section of the strata passed through (Fig. 111):

1. Detritus,	10′
2. Hard white loose-grained sandstone,	10′
3. Black slate,	1″
4. *Coal*,	1′
5. Fireclay,	2′ 10″+

In this shaft only 2 feet 10 inches of the fireclay had been dug into at the time the locality was visited. Mr. Hagadorn reported that the bed had been found 16 feet thick in the immediate vicinity.

§ 255. *Armstrong Lot.*—On this farm, which lies between the Hagadorn farm and Lafayette, two drill-holes were bored, and the records reported as follows (Fig. 113):

Boring No. 3, Armstrong Lot.

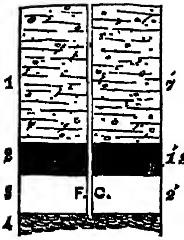
1. Detritus,	4′	to 4′
2. Soft, shaly rock,	4′	to 8′
3. Shales,	2′ 2″	to 10′ 2″
4. Coal,	4′ 4″	to 14′ 6″

Boring No. 5, Armstrong Lot (Figs. 117 and 106).

1. Detritus,	7′	to 7′
2. White SS.,	26′	to 33′
3. *Coaly* matter,	9″	to 33′ 9″
4. Soft SS.,	29′ 9″	to 63′ 6″
5. *Coal*,	4′ 3″	to 67′ 9″
6. Slate,	9′ 6″	to 77′ 3″
7. SS.,	3′	to 80′ 3″

These holes were not located and their elevation is not known. A shaft was sunk on the Watter's lot and the following section reported (Fig. 109):

Fig. 108. p. 214.
Boring V.
Lafayette Coal C°



UNIDENTIFIED COAL

Fig. 110. p. 214.
Boring W.
Lafayette Coal Co.

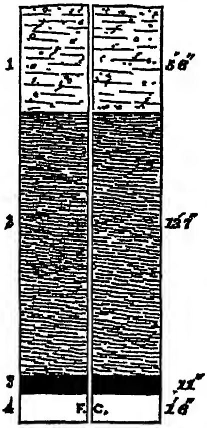


Fig. 112. p. 215.
Hagadorn Farm.

Fig. 109. p. 216.
Shaft. Watter's Farm.

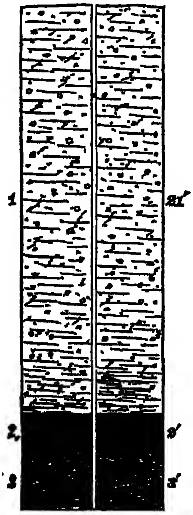
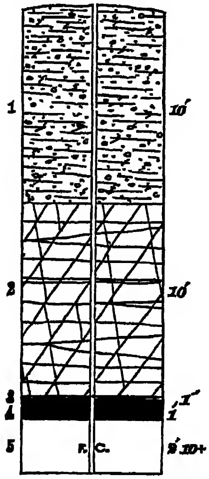
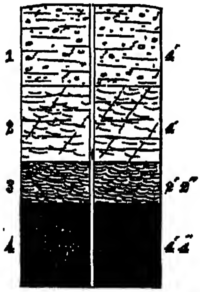


Fig. 111. p. 216.
Hagadorn Farm.



Hagadorn Fireclay bed.

Fig. 113. p. 216.
Boring N° 3.
Armstrong Lot.



1. Detritus,	21′	to 21′
2. Coal,	2′	to 23′
3. Slate,	3′	to 26′

§ 256. *Davis farm.*—Mining in the old Davis mine near Lafayette has been abandoned for a number of years. At the time the development was started the property was very thoroughly explored both by drill-holes, shallow shafts and drifts. It is a fact worthy of mention that in all the drill-holes which have been bored in the township for testing the coal beds exclusively, both the highest and lowest geological strata have been pierced by the drill-holes on the Davis farm.

The Davis mine is about a quarter of a mile south-west of Lafayette cross-roads. The elevation of the track at the mouth of the drift is 2141 feet above ocean level. Mr. L. W. Crawford, formerly superintendent of the Davis mine, reports that the average thickness of the bed in the old workings was 5 feet of solid coal with a slate roof and fireclay floor (Fig. 114).

1. Slate,	—
2. *Coal,*	5′
3. Fireclay,	—

The coal is the Clermont (Clarion) bed, and is the first workable bed found above the *Alton group*. The main drift of the mine had caved in when visited, and it was not possible either to examine the workings or see the face of the coal.

A drill-hole was started on the highest point of the hill directly over the mine, the elevation being 2183 feet. The drill was pushed to a depth of 75 feet 6 inches, and the following stratification was disclosed (Fig. 121):

1. Detritus,	5′		to	5′	
2. SS.,	10′		to	15′	
3. Blue slate,	5′	8″	to	20′	8″
4. White SS.,	6′	4″	to	27′	
5. Blue slate,	10′		to	37′	
6. Black slate,	8′		to	45′	
7. Fireclay and white SS.,	7′	6″	to	52′	6″
8. White SS.,		6″	to	53′	
9. Dark SS.,	17′		to	70′	
10. Mixed SS. and smut,	3′	6″	to	73′	6″
11. Black slate mixed with SS.,	2′		to	75′	6″

Fig. 114. p. 218.
Clermont Bed
Davis Mine.

Fig. 116. p. 230.
Clermont bed.
Whitman Farm.

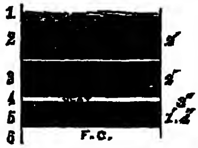


Fig. 118. p. 224.
Alton Coal Group.
Drill hole No. 5.
Bullock Farm.

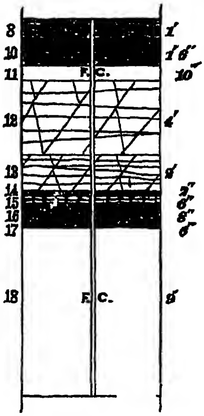


Fig. 115. p. 220.
Clermont coal & over shales. Davis Farm.

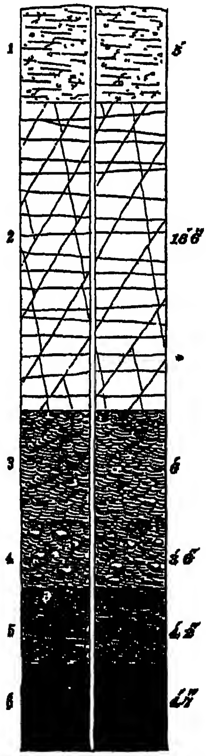


Fig. 117. p. 216.
Boring No. 5. Armstrong Lot.

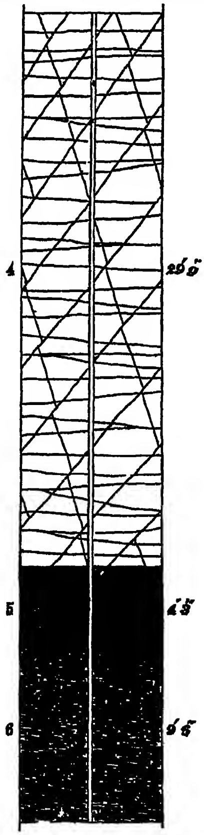
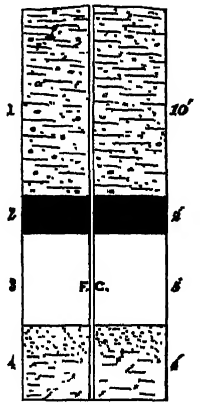


Fig. 119. p. 220.
Shaft. Davis Farm.



It will be noticed that no coal bed is shown in this section, although the drill pierced the strata over thirty feet under the floor of the mine. The horizon of the coal bed is in the black slate noted from 37 to 45 feet. The coal was either mistaken by the drillers for black slate, or the coal has been replaced by the slate. A second hole was drilled in the same hill, and the coal was struck at a depth of 35 feet 2 inches, the bed being 4 feet 7 inches thick.

The following is the record (Fig. 115):

1. Detritus,	5′		to	5′	
2. Red SS.,	16′	6″	to	21′	6″
3. Dark shale,	6′		to	27′	6″
4. Shale, with nodular iron ore,	3′	6″	to	31′	
5. Dark slate,	4′	2″	to	35′	2″
6. *Coal,*	4′	7″	to	39′	9″

The two sections have the same general characteristics.

A shaft was dug to a depth of 21 feet near the outcrop of the coal, and to the west of the mine. The rocks passed through are shown in the section (Fig. 119):

1. Detritus,	10′	to	10′
2. *Coal,*	2′	to	12′
3. Fireclay,	5′	to	17′
4. Sand and yellow clay,	4′	to	21′

About a quarter of a mile southwest of the mouth of the mine, near the spring head of a brook which flows into Wintergreen run, a hole was drilled to a depth of 84 feet 7 inches. The elevation of the top of the hole is 1946 feet, and the record as follows (Fig. 122):

1. Detritus,	10′		to	10′	
2. SS.,	8′		to	18′	
3. Hard SS.,	7′		to	25′	
4. Soft slaty SS.,	28′		to	53′	
5. Hard dark SS.,	7′		to	60′	
6. Hard brown SS.,	11′		to	71′	
7. Shale,	10′		to	81′	
8. Iron rock,		3″	to	81′	3″
9. *Coal,*	3′	4″	to	84′	7″

The hole commences at about the bottom of the OLEAN CONGLOMERATE. The top of the SUB-OLEAN CONGLOMERATE was met at a depth of 53 feet, and is represented by a dark, hard, brown sandstone; a second layer of sandstone repre-

senting the lower part of the SUB-OLEAN, lies probably underneath the bottom of the hole. As no coal has ever been found at this geological horizon, I cannot credit the existence of a seam 3 feet 4 inches thick, as reported in the record. The remarks on the sections constructed from the cuts made on the Three Mile run are not inapplicable here.

§ 257. *Matthews' farm*—A drill hole was bored on this farm, one mile a little west of south of Lafayette. The work was done under the direction of Mr. L. W. Crawford, from whom the record was obtained. The elevation of the top of the hole is 2114 feet above tide, and the strata encountered are shown in the following section (Figs. 123 and 127:

1. Detritus,	10′	to	10′
2. SS.,	11′ 6″	to	21′ 6″
3. Pale SS.,	9″	to	22′ 3″
4. Gray SS.,	5′	to	27′ 3″
5. White SS.,	6′	to	33′ 3″
6. Red SS.,	6′ 6″	to	39′ 9″
7. White SS.,	2′	to	41′ 9″
8. Brown SS.,	10″	to	42′ 7″
9. White SS.,	6″	to	43′ 1″
10. Brown SS.,	4′	to	47′ 1″
11. White SS.,	1′	to	48′ 1″
12. Blue slate,	4″	to	48′ 5″
13. White SS.,	3′ 2″	to	51′ 7″
14. Black slate,	4″	to	51′ 11″
15. *Coal*,	1″	to	52′
16. White SS.,	1′	to	53′
17. Blue slate,	8′ 10″	to	61′ 10″
18. Black slate,	2′ 11″	to	64′ 9″
19. *Coal, (Alton Upper bed,)*	1′ 2″	to	65′ 11″
20. White SS.,	11′ 7″	to	77′ 6″
21. Black slate,	2′	to	79′ 6″
22. *Coal, (Alton Middle bed,)*	3′ 9″	to	83′ 3″
23. Fireclay,	2″	to	83′ 5″
24. Black slate,	4″	to	83′ 9″
25. Blue slate,	1′	to	84′ 9″
26. Gray SS.,	1′ 6″	to	86′ 3″
27. White pebble rock,	4′ 2″	to	90′ 5″
28. White SS.,	8′ 10″	to	99′ 3″
29. *Coal, (Alton Lower bed,)*	2″	to	99′ 5″
30. Blue slate,	6″	to	99′ 11″
31. Soapstone,	3′ 3″	to	103′ 2″
32. White SS.,	1′ 4″	to	104′ 6″
33. Blue slate,	3′	to	107′ 6″
34. Blue SS.,	12′ 6″	to	120′

Down to a depth of 64 feet 9 inches the drill passed through the JOHNSON RUN SANDSTONE. The character of the sandstone is that which generally distinguishes the Johnson run rock. The strata are quite different from those which represent the same interval in the center of the coal basin in the vicinity of Alton and Bond Vein. The dynamical conditions under which the *Alton coal group* and the JOHNSON RUN SANDSTONE were deposited must have been quite different at Lafayette from what existed at Alton. The *Alton group* has quite a different thickness and character in the two localities. The *Alton Middle coal bed* which is the only coal which has a workable thickness was struck at a depth of 79½ feet. The coal which was taken from the bore hole was reported bright and lusterous and apparently of a good quality. I do not consider that a correct judgment can be formed as to the economical value of a bituminous coal from the pounded drillings taken from a bore hole.

§ 258. *Lincoln farm.*—A drill hole was bored on this farm about a mile and a half northeast of Lafayette.

The reported record of the hole is as follows (Fig. 120):

	1. Detritus,	4' 6"	to	4' 6"
Kinzua creek sandstone.	2. Brown sandrock,	12'	to	16' 6"
	3. Blue SS.,	2'	to	18' 6"
	4. Brown SS. with balls of iron ore,	14' 6"	to	33'
	5. Fireclay,	4'	to	37'
	6. White SS.,	20'	to	57'
	7. Shale,	6"	to	57' 6"
	8. Gray compact SS.,	12'	to	69' 6"
	9. Light brown SS.,	11'	to	80' 6"
	10. *Coal, (Marshburg,)*	1' 6"	to	82'
Olean Conglomerate.	11. Light brown SS,	4'	to	86'
	12. Brown pebbly SS.,	3'	to	89'
	13. Black slate,	4' 3"	to	93' 3"
	14. Soft brown SS.,	12' 3"	to	105' 6"
	15. Hard gray SS.,	7' 6"	to	113'
	16. Soft brown SS.,	2'	to	115'
	17. White quartzose SS.,	9'	to	124'
	18. Hard brown pebbly SS.,	1' 3"	to	125' 3"
	19. Soft pebbly SS.,	1' 6"	to	126' 9"
	20. Soft brown SS.,	6"	to	127' 3"
	21. Compact brown and olive SS.,	13' 3"	to	140' 6 '

The hole is located on the eastern edge of the Lafayette

Fig. 120. p. 222.
Lincoln farm

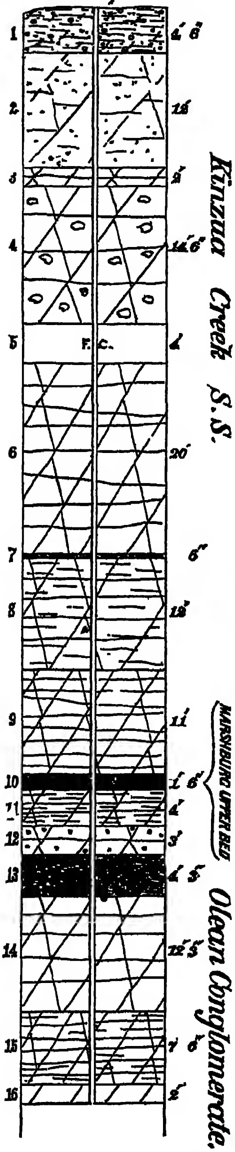


Fig. 120.
continued.

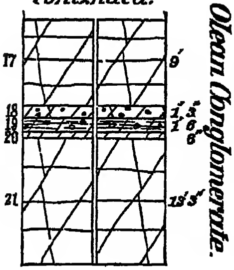


Fig. 121. p. 218.
Davis farm.

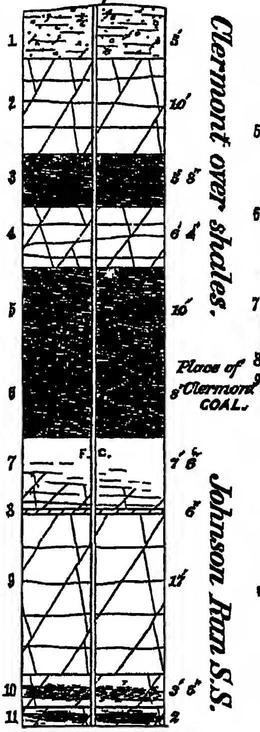
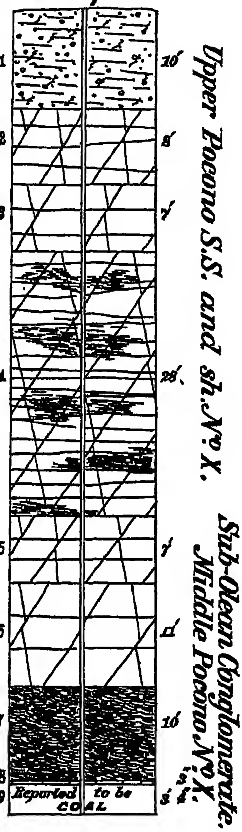


Fig. 122. p. 220.
Davis farm



This is the only record published in Lafayette township in which the Sub-Olean Conglomerate is shown.

plateau but a short distance west of the outcrop of the Kinzua creek sandstone and Olean Conglomerate. Its elevation above tide is 2144 feet.

The top of the hole is just below the horizon of the *Alton Middle coal bed* and the drill pierced the strata at a depth of 140 feet 6 inches, passing through the Kinzua creek sandstone, the Marshburg coal bed and the Olean Conglomerate.

§ 259. *Bullock farm.*—This farm is near the center of the Lafayette plateau, north-east of Lafayette village. Mr. James E. Butts, the present owner, has thoroughly tested the coal beds both by drill-holes and drifts, and the structure is well made out.

The position of the drill-holes is given on the map of the Alton coal basin (Plate XII). The highest geological stratum pierced by the drill was in hole No. 1 where the Clermont coal bed was struck, 10 feet below the surface of the ground, immediately under detritus.

The elevation of the hole is 2152 feet above tide. The hole was bored on the east side of the road, about 1200 feet north of the old house. The record is as follows (Figs. 124 and 137):

1. Detritus,	9′	to 9′
2. Rotten SS.,	1′	to 10′
3. *Coal* (*Clermont bed*),	2′	to 12′
4. Light brown SS.,	11′	to 23′
5. Hard slate rock,	17′	to 40′
6. White SS.,	10′	to 50′
7. Hard pebble rock,	17′	to 67′
8. Compact SS., mixed with *coal* (upper bed, Alton group,	3′	to 70′
9. Hard pebble rock,	8′	to 78′
10. SS., mixed with *coal* (Alton bed),	1′ 3″	to 79′ 3″
11. SS., dark and pebbly,	2′ 9″	to 82′

The total depth of the hole was 82 feet, and it went through the *Clermont coal bed,* the JOHNSON RUN SANDSTONE, and the *Alton coal group* to below the *Alton middle coal bed.* None of the coals reported in the record are of sufficient thickness to prove workable.

Drill-hole No. 5 was bored directly to the rear of the old barn, and 1275 feet a little west of south of hole No. 1.

The elevation of the top of No 5 is 2126 feet, and the following strata were pierced (Figs. 126 and 118):

Johnson Run Sandstone.	1.	Detritus,	5′	to	5′
	2.	Sandy shale,	12′ 6″	to	17′ 6″
	3.	Black slate,	1′	to	18′ 6″
	4.	White SS.,	14′	to	32′ 6″
	5.	Blue slate,	12′	to	44′ 6″
	6.	Very compact white SS.,	3′	to	47′ 6″
	7.	Blue slate,	4′	to	51′ 6″
	8.	Black slate,	1′	to	52′ 6″
	9.	Coal and slate, mixed, (Alton bed),	1′ 6″	to	54′
	10.	Fireclay,	10″	to	54′ 10″
	11.	Dark blue SS.,	4′	to	58′ 10″
	12.	White SS.,	2′	to	60′ 10″
	13.	Smut,	2″	to	61′
	14.	Nodular iron ore,	6″	to	61′ 6″
	15.	Black slate,	8″	to	62′ 2″
	16.	*Coal, (lower bed, Alton group)*,	6″	to	62′ 8″
	17.	Indurated fireclay,	9′	to	71′ 8″
Kinzua Creek Sandstone.	18.	White SS., with blue pebbles,	11′ 8″	to	83′ 4″
	19.	Coarse conglomerate,	12′	to	95′ 4″
	20.	Red conglomerate,	4′	to	99′ 4″
	21.	Blue rock, fossiliferous *limestone ?*	2′ 2″	to	101′ 6″
	22.	Fireclay,	2′	to	103′ 6″
	23.	Blue rock, fossiliferous,	12′	to	115′ 6″
	24.	Coarse conglomerate,	3′ 6″	to	119′

The hole commences in the Johnson run sandstone, passes through this sandstone, the Alton coal group and the Kinzua creek sandstone.

If the identification proposed for the two coal beds, which were struck, be correct, the upper bed of the Alton group is not reported in the record. About midway between holes Nos. 1 and 5, hole No. 3 was drilled to a depth of 55 feet. The elevation of the top of the hole is 2128 feet, and the rocks passed through were as follows (Fig. 133):

1.	Detritus,	10′	to	10′
2.	Fine-grained white SS.,	14′	to	24′
3.	Marly shale,	10″	to	24′ 10″
4.	Compact blue slate,	4′ 2″	to	29′
5.	Black slate,	1′	to	30′
6.	*Coal* and slate mixed,	2′	to	32′
7.	Fireclay, slightly indurated,	2′ 3″	to	34′ 3″
8.	Compact, brown SS.,	1′	to	35′ 3″
9.	Compact, white SS. quartz,	6′	to	41′ 3″
10.	Nodular iron ore,	10″	to	42′ 1″
11.	Fine black slate,	10″	to	42′ 11″
12.	*Coal* and slate mixed,	2′	to	44′ 11″
13.	Fireclay,	4′	to	48′ 11″
14.	Compact, white, quartzose SS.,	6′	to	54′ 11′

It seems most probable that the coal bed struck at a depth of 30 feet is the *Alton Middle bed*, and yet the character of the strata is such that it is possible that the lower bed may be the Alton. A general survey of all the facts bearing upon the stratification of the rocks underlying the Bullock farm has led me to infer that the upper coal bed of the *Alton group* has no representative in the series.

Drill hole No. 2 is located 500± feet southwest of No. 5. The elevation of the top of the hole is 2108 feet, and the drill went through 10 feet of detritus and 33 feet of white sandstone, representing the JOHNSON RUN ROCK. The *Alton group* was not reached.

The location of drill hole No. 4, was not determined; 8 feet of detritus and 25 feet of white quartzose sandstone were reported to have been drilled through. The sandstone is evidently the JOHNSON RUN.

A shaft was dug 30 feet deep east of drill hole No. 1, and the following rocks encountered (Fig. 125):

1. Detritus,	7′	to 7′
2. Slate,	8″	to 7′ 8″
3. *Coal*, with thin parting of slate,	1′ 5″	to 9′ 1″
4. Slate,	1′	to 10′ 1″
5. Shale,	18′	to 28′ 1″
6. Sandrock,	2′	to 30′ 1″

East of drill hole No. 2. a shaft was dug near the outcrop of the coal bed to a depth of 12 feet 8 inches, and went through 1 foot 8 inches of coal.

The dip of the coal under the northern portion of the Bullock farm is to the north or toward the Newell farm.

§ 260. *Newell farm.*—This farm adjoins the Bullock farm on the north, and lies to the east of the county road. The *Clermont coal* has been opened and mined in the old drift, which is now fallen shut. A number of shafts have been sunk through the coal bed, near its outcrop, and the records have been reported by Mr. Butts. The exact location or elevation of the shafts are not known.

Shaft No. 9, Newell Farm (Fig. 129).

1. Detritus,	14′	to 14′
2. Slate,	1′	to 15′
3. Coal,	5′ 6″	to 20′ 6″

Fig. 123. p. 221.
Matthews farm.

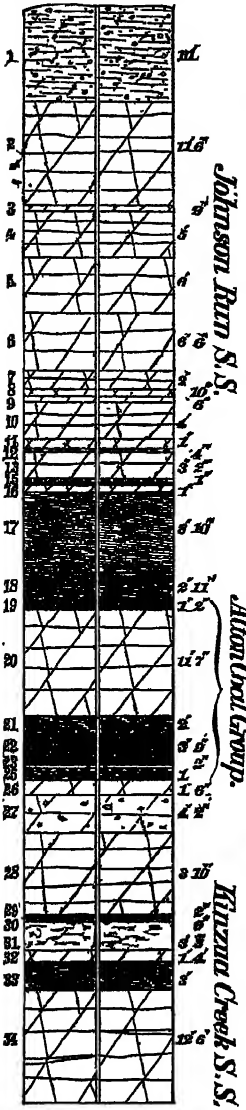


Fig. 124. p. 224.
Bullock farm.

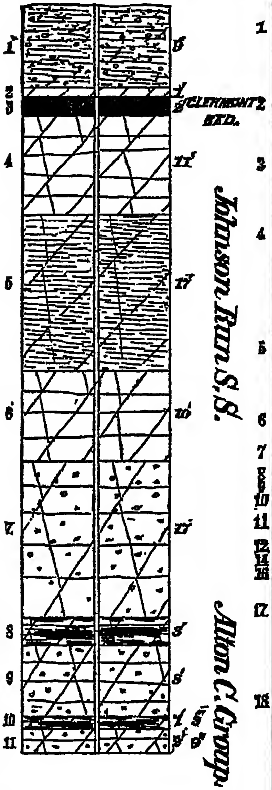


Fig. 125. p. 226.
Bullock farm.

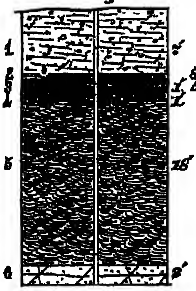
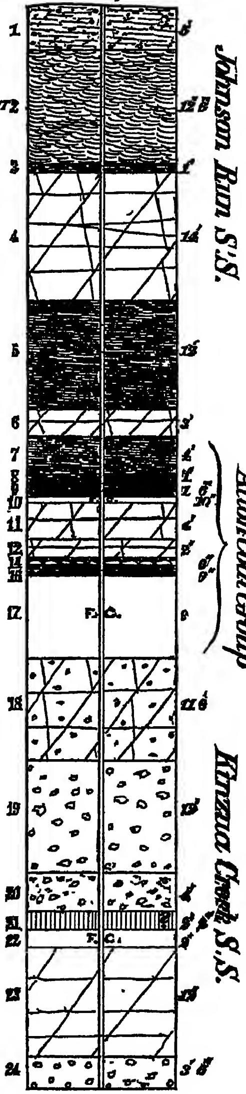


Fig. 126. p. 224.
Bullock farm.



The local authorities state that the Newell coal was always regarded as a *five foot bed*, so that the thickness reported in the above section is not an excessive one. The bed is not broken up by slate, but is one solid bench of coal.

Shaft No. 10, Newell Farm.

1. Detritus,	9′	to 9′
2 Slate,	2′	to 11′
3. Slate, mixed with *coal*,	4′	to 15′
4. SS.,	18′	to 33′

This shaft was evidently so near the outcrop, and there was so little cover to the coal, that the bed was not found solid.

Shaft No. 11, Newell Farm.

1. Detritus,	9′	to 9′
2. SS.,	17′	to 26′

This shaft commenced below the coal, and the sandstone encountered was the JOHNSON RUN ROCK.

Shaft No. 12, Newell Farm.

1. Detritus,	4′	to 4′
2. *Coal* smut,	2′	to 6′
3. SS.,	13	to 19′

This shaft also shows the outcrop of the *Clermont coal bed* and the underlying JOHNSON RUN SANDSTONE.

Shaft No. 13, Newell farm (Fig. 132).

1. Detritus,	8′	to 8′
2. SS.,	3′	to 11′
3. Slate,	5′	to 16′
4. *Coal*,	2′ 6″	to 18′ 6″
5. SS.,	3′	to 21′ 6″

This shaft was located south of the Newell coal opening.

Shaft No. 14, Newell farm (Fig. 130).

1. Detritus,	6′	to 6′
2. Slate,	6′	to 12′
3. Coal,	4′ 6″	to 16′ 6″

The position of this shaft is directly east of the opening.

Fig. 127. p. 221.
Alton Upper & Middle bed. Matthews Farm.

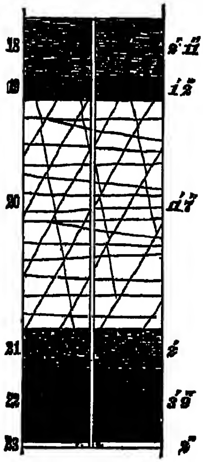


Fig. 129. p. 226.
Clermont Coal bed. Shaft No. 9. Newell Farm.

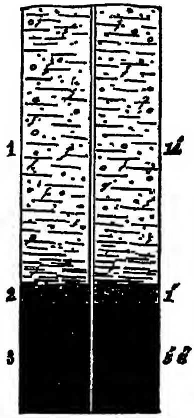


Fig. 131. p. 230.
Clermont Coal bed. Shaft. Whitman Farm.

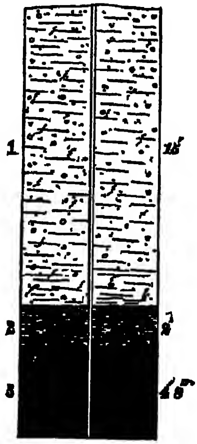


Fig. 128. p. 230.
Clermont Coal bed. Shaft No. 15. Newell Farm.

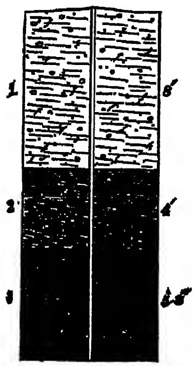


Fig. 130. p. 228.
Clermont Coal bed. Shaft No. 14. Newell Farm.

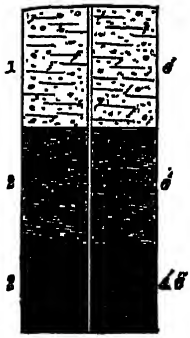
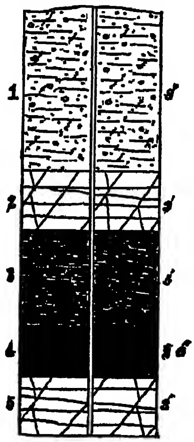


Fig. 132. p. 228.
Shaft No. 13. Newell Farm.



Shaft No. 15, Newell farm (Fig. 128).

1. Detritus,	8′	to 8′
2. Slate,	4′	to 12′
3. Coal,	5′ 8″	to 17′ 8″

This shaft is in close proximity to No. 14.

The coal bed was reported thicker in this shaft than at any other point on the property.

NOTE.—The following is an analysis of the Newell coal reported by Messrs. Owen and Needham:

Water,	1.50
Volatile matter,	37.50
Fixed carbon,	56.00
Ash,	5.00
	100.00
Coke, per cent.,	61.
Color of ash,	light gray.
Specific gravity,	1.318

§ 261. *Whitman farm.*—This farm is on the Lafayette plateau 1¼ miles northeast of the Newell farm.

A coal bed has been opened east of the county road. The elevation of the bottom of the bed being about 2130 feet above tide.

The opening had fallen shut when visited but a section of the coal has been reported as follows (Fig. 116):

1. Slate roof,	—
2. *Bituminous coal,*	2′
3. *Cannel coal,*	2′
4. Clay parting,	3″
5. *Bituminous coal,*	1′ 4″
6. Fireclay floor,	—

A shaft was dug near the opening and the following rocks reported (Fig. 131):

1. Detritus,	15′	to 15′
2. Slate,	2′	to 17′
3. *Coal,*	4′ 8″	to 21′ 8″

From what could be learned as to the character of the Whitman coal there seems to be some marked differences between it and the Newell, and yet the structure is such as to make it quite probable that the two openings are on the same bed. In this case the Davis mine, the Newell

mine and the Whitman mine would all be located in the *Clermont bed* *

The following are analyses of the Whitman coal reported by Messrs. Owen and Needham:

	1.	*2.*
Water,	2.0	2.0
Volatile matter,	38.2	31.3
Fixed carbon,	54.8	64.2
Ash,	5.0	2.5
	100.0	100.0
Coke, per cent.,	59.8	66.7

§ 262. *Phette place farm.*—This farm is located on the southern prong of the Marshburg plateau and about 2¼ miles in an air line northwest of Lafayette.

A drill hole was bored on the south side of the old road to a depth of 82 feet, the following section was reported (Fig. 135):

1.	Detritus,	19′ to 19′
2.	Brown and olive shales,	21′ to 40′
3.	White SS.,	31′ to 71′
4.	Blue slate,	7′ to 78′
5.	Black slate,	3′ to 81′
6.	White SS.,	1′ to 82′

The elevation of the top of the hole is 2165 feet. The thirty-one feet of white sandstone pierced is probably the representative of the Johnson run rock. The blue and black slate immediately below the sandstone in this case would represent the upper part of the Alton group.

§ 263. *Camp Lot.*—Immediately south-west of the Phette place farm lies the Camp lot. Here one of the Alton group coals (possibly the upper bed) has been opened in a drift, which has now fallen shut, at the head of the east fork of Turnip run. The bed was reported to be from 2 to 2½ feet thick. The elevation of the bottom of the coal at this point

* According to Messrs. Owen and Needham the Newell coal is 35 feet above the Whitman, and the bed opened in the Davis mine is 155 feet above the Newell coal.

Mr. Butts, in whose judgment every confidence is to be placed, considers that these three mines are opened on the same coal bed.

is 2093 feet above tide. In close proximity to the coal opening a hole was drilled to the depth of 45 feet, and the following rocks were pierced (Figs. 134 and 140):

1. Detritus,	5′	to 5′
2. Light shale,	2′ 8″	to 7′ 8″
3. Dark SS.,	6′ 6″	to 14′ 2″
4. Brown and white SS.,	3′ 10″	to 18′
5. Dark SS.,	7″	to 18′ 7″
6. White SS.,	1′ 5″	to 20′
7. Dark shale,	3′ 6″	to 23′ 6″
8. White SS.,	4″	to 23′ 10″
9. Brown SS.,	1′ 9″	to 25′ 7″
10. Dark shale,	5′ 5″	to 31′
11. Blue slate,	7′	to 38′
12. Smut,	1′	to 39′
13. *Coal*,	3′ 6″	to 42′ 6″
14. Slate,	6″	to 43′
15. Black SS.,	1′ 10″	to 44′ 10″
16. White SS.,	2″	to 45′

The coal, which is reported 3 feet 6 inches thick near the bottom of the section, is no doubt the same coal bed that was opened in the drift; but this cannot be positively stated, as the elevation of the top of the hole is not known.

§ 264. *Newcomb farm.*—This farm lies to the east of the Marshburg-Lafayette road, about one mile southeast of the former town. Two shafts were dug on this farm to a depth of 40 and 29½ feet, respectively. The location of shaft No. 1 is near the —— corner of the farm. The following section was reported (Fig. 138):

1. Detritus,	7′		to 7′
2. *Coal*,		2″	to 7′ 2″
3. Nodular ore,	4′		to 11′ 2″
4. *Coal*,		4″	to 11′ 6″
5. Bluish-green fireclay,	5′		to 16′ 6″
6. Olive SS.,	5′		to 21′ 6″
7. Black slate,	6′		to 27′ 6″
8. Nodular ore,	2′		to 29′ 6″
9. Jet black slate,	—		—

The two small streaks of coal found immediately under the drift are possibly representatives of one of the *Alton group coal beds*. The elevation of this shaft is not known.

To the rear of the old log house, shaft No. 2 was located

Fig. 133. p. 225.
Bullock farm.

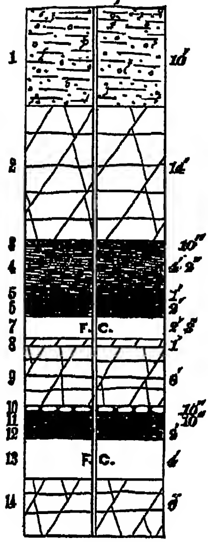


Fig. 134. p. 232.
Camp lot.

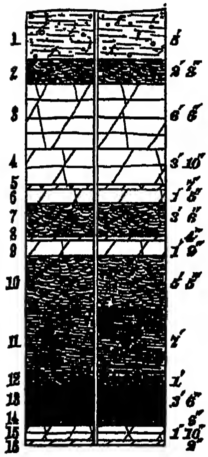


Fig. 135. p. 231.
Phette place farm.

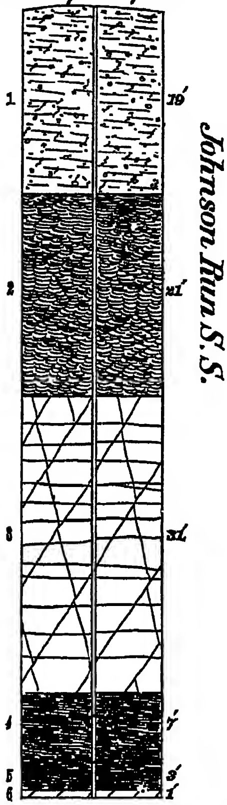
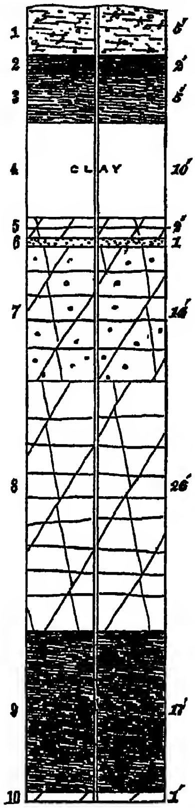


Fig. 136. p. 236.
McK. C. Bit. C. Co.



The only coal beds which have been found of workable size in Lafayette township, are the Clermont bed and the Alton middle bed. The former has been mined on the Lafayette plateau; the latter at Alton and Bond Vein.

at an elevation of 2159 feet above tide; the section was reported as follows (Fig. 139):

1.	Detritus,	8′	to 8′
2.	Fireclay,	8′	to 16′
3.	*Coal,*	1′	to 17′
4.	Fireclay,	2′	to 19′
5.	Blue, bony slate,	4″	to 19′ 4″
6.	Blue slate,	2′	to 21′ 4″
7.	Dark shale and slate, full of mica,	2′	to 23′ 4″
8.	Black slate,	10′	to 33′
9.	"Lean black-band,"	1′	to 34′
10.	Indurated fireclay, with plant remains,	4′	to 38′
11.	Dark gray SS.,	2′	to 40′

Judging from the position and elevation of this shaft the one foot coal bed struck at a depth of 16 feet is doubtless the *upper bed of the Alton group*.

The lean black-band iron ore found 33 feet down is more likely to be *coaly* black slate than iron ore. It is in about the position of the *lower bed of the Alton group.*

A number of the local geologists have reported valuable *black-band iron ores* in Lafayette township. Some of *the authorities* have gone so far as to estimate the number of tons of pig iron which the township was capable of producing annually at competing market rates.

I have never seen a specimen of *commercial black-band iron ore* which was found in the township. The natural rock exposures are so bad and limited, that it would be impossible to make a final authoritative statement as to the occurrence of these ores, without making such explorations as the limited funds of the Survey would not permit.

§ 265. *Turner farm.*—On this farm, which is west of Marshburg and south of the county road, a hole was drilled to a depth of 114 feet, and the following record reported (Fig. 141):

Kinzua Creek SS.	1.	Detritus,	12′	to 12′
	2.	Brown SS.,	2′	to 14′
	3.	Gray SS.,	2′	to 16′
	4.	Red conglomerate,	2′	to 18′
	5.	Blue Slate,	3′	to 21′
	6.	White SS.,	16′	to 37′
	7.	Gray SS.,	2′	to 39′
	8.	White SS.,	3′	to 42′

Fig. 137. p. 224.

Outcrop. Clermont bed. Bullock Farm.

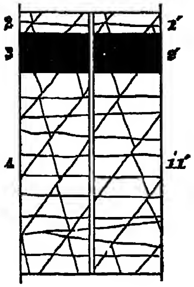


Fig. 138. p. 232.

Shaft No. 1. Newcomb Farm.

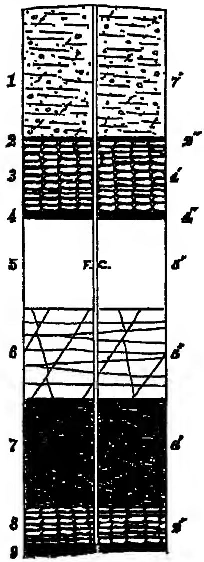


Fig. 139. p. 234.

Shaft No. 2. Newcomb Farm.

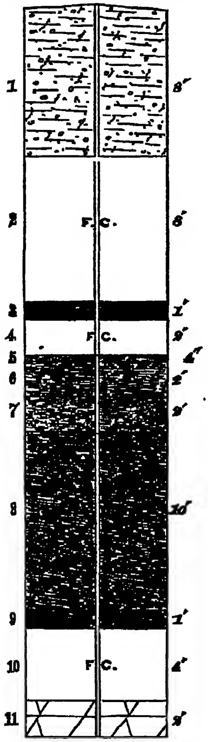
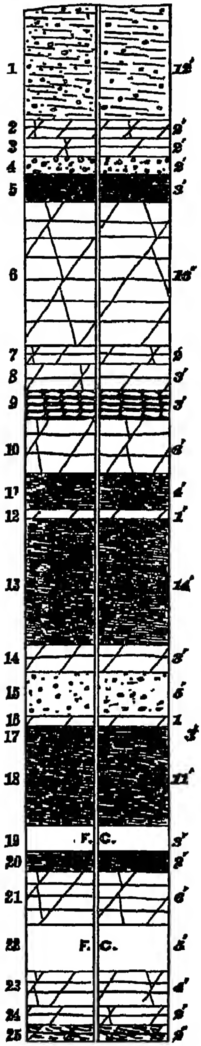


Fig. 140. p. 232.

Camp Lot Coal bed.

Fig. 141. p. 234.

Turner Farm. Scale 20=1.



D. B. Harden, del.

OLEAN CONGLOMERATE.	9. Nodular iron ore, (*Marshburg coal horizon,*)	3′	to 45′
	10. Dark brown SS.,	6′	to 51′
	11. Blue slate,	4′	to 55′
	12. Brown SS.,	1′	to 56′
	13. Blue slate,	14′	to 70′
	14. Dark-brown SS.,	3′	to 73′
	15. Coarse conglomerate,	5′	to 78′
	16. Brown SS.,	1′	to 79′
	17. Red SS.,	3″	to 79′ 3″
	18. Blue slate,	11′	to 90′ 3″
	19. Fireclay,	3′	to 93′ 3″
	20. Blue slate,	2′	to 95 3″
	21. Gray SS.,	6′	to 101′ 3″
	22. Indurated fireclay,	5′	to 106′ 3″
	23. Dark-gray SS.,	4′	to 110′ 3″
	24. Red SS.,	2′	to 112′ 3″
	25. Brown and olive shaly SS.,	2′	to 114′ 3″

This hole was drilled in the old log house, the elevation being 2066 feet. The drill commenced to bore below the *Alton coal group*, pierced the greater part of the KINZUA CREEK SANDSTONE, 3 feet of nodular iron ore, representing the *Marshburg coal horizon*, went through the entire thickness (56 feet) of the OLEAN CONGLOMERATE, and penetrated 13 feet into the shales and sandstone lying between the OLEAN and SUB-OLEAN CONGLOMERATES.

The following record was reported by Mr. L. W. Crawford. The exact location is not known, but it is thought to be below the old coal shutes belonging to the McKean County Bituminous Coal Co., near Lafayette (Fig. 136):

1. Detritus,	5′	to 5′
2. Black slate,	2′	to 7′
3. Light slate,	5′	to 12′
4. Blue clay,	10′	to 22′
5. SS.,	2′	to 24′
6. Sand,	1′	to 25′
7. Pebbly SS.,	14′	to 39′
8. White SS.,	26′	to 65′
9. Slate,	17′	to 82′
10. Hard rock,	1′	to 83′

Strata from No. 5 to 8, inclusive, of this section represent without doubt, the KINZUA CREEK SANDSTONE.

Chapter XIII.

Wetmore Township.

§ 266. Wetmore occupies the southwestern corner of the county. The southern portion lies east of Sheffield township Warren county and the northern portion east of the southern portion of Hamilton. On the north lies Hamilton and western Hamlin and on the east Hamlin and Sergeant.

The township is drained by the Tionesta, Kinzua and Clarion creeks. The largest part is contained in the basin of the Tionesta (page 6). The topography is quite rugged and not unlike that of Sergeant and Hamlin. The greatest *measured* height is *2150'*, in the northeastern corner along the Big Level road. The summit in the northern part immediately south of Fife run is apparently higher, but no elevation was determined. The lowest point is where the Kinzua creek (south branch) crosses the northern boundary line at an elevation of about *1400'*.

§ 267. The entire township lies in the Sixth bituminous coal basin. The southeastern corner of the township approaches within ¾ mile of the Smethport or Fifth anticlinal axis.

Mr. Dalson in his examinations for the McKean, Elk, Land and Improvement Company was led to believe that the township was crossed by subordinate anticlinal axes having a general parallel direction to the Smethport. The facts which I was able to obtain were not sufficiently numerous to assert either the existence or probable location of these flexures.

§ 268. The determination of the dip of the coal measures depends of course upon the proper location of the axes which undulate the strata. In the adjoining townships the dips have been estimated from the elevation of the bottom of the Olean Conglomerate; in Wetmore the elevation of this horizon was only ascertained at the following places:

Township line west of Kinzua well,	1900′
Kane,	1870′ (?)
Wetmore station P. & E. R. R.,	1868′
Coburn dry hole,	1830′

Generally throughout the township there is a progressive southwest dip ranging from 15 to 25 feet per mile. No just appreciation of the dips in a northwest and southeast direction can be had from the facts at hand. At a maximum they do not possibly exceed 50 feet per mile.

The dip of the outcropping strata is of but little economical value as no coal beds of workable thickness and purity have been found in the township.

A knowledge of the dip of the Bradford oil sand is of great importance to the oil prospector but this could not be authoritatively stated from a study of the surface rocks, as we do not know whether the thickness of the interval between the surface conglomerates and oil sand remains constant. Sufficient wells have been drilled to have settled this question beyond a doubt, but it has been impossible to impress upon the drillers the importance of keeping careful records and reporting them to the survey for examination and study. The average oil prospector *guesses* at the proper depth to which his well should go to pierce the horizon of the oil producing sand. Some of the wells are stopped far above the level at which it is possible to find petroleum and the drilling results in a useless expenditure of capital as it proves nothing for or against the oil productiveness of the territory.

The only oil well records obtained in the township are those of the Coburn and Ernhout and Taylor No. 2 wells, which are given below.

§ 269. The aggregate thickness of rocks exposed in Wetmore above water level, is about 575 feet, grouped under the following formations:

Coal Measures, (including the conglomerate No. XII,)	175′
Mauch Chunk No. XI, } Pocono No. X, }	325′ ±
Red Catskill No. IX,	75′ ∓
Total,	575′

The highest geological stratum is the shale capping the

Clermont coal bed in the vicinity of the village of Kane. The lowest stratum is found on the south branch of Kinzua creek, where 75 feet (more or less) of the upper portion of the Catskill formation is found outcropping above water level.

The record of the Coburn dry hole, north of Sergeant station, would extend the section downward 1800 feet further through the remainder of the Catskill formation, and the Chemung to a depth of 225 feet below the Bradford oil sand,* so that the total length of the township section is about 2400 feet.

§ 270. The rocks of the *Carboniferous* formation have not been explored as extensively as in the adjoining townships of Sergeant, Hamlin, and Lafayette. The general character of the sections in all of these townships changes but little. The intervals between the coal beds remain about the same. The following is a general section of the coal measures in the vicinity of Kane:

1. Shales,	15′ to 20′
2. *Coal, (Clermont bed,)*	2′±
3. Fire clay,	—
4. Pink and yellowish sandrock, (JOHNSON RUN SANDSTONE,)	50′
5. *Alton coal group*, containing *coal* shales and fire clays,†	15′±
6. Conglomeritic sandstone (KINZUA CREEK SANDSTONE),	45′
7. Upper *Marshburg coal* and shale interval,	5′ to 10′
8. Coarse grained conglomeratic sandstone, (OLEAN CONGLOMERATE,)	60′

§ 271. The Clermont over shales compose the *most recent* strata which have been noticed in the township. They are to be found capping most of the highest summits, especially those lying between the East Branch Tionesta creek and South Branch Kinzua creek. The cellar of General Thomas L. Kane's house is excavated from the drift overlying these shales. A shaft was dug near the house to a depth of 19 feet, in order to test the underlying coal, (*Clermont bed.*) Considerable gas and foul air was

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* It is quite probable that the bottom of the sand, representing the BRADFORD SAND, has been placed too low from an over-estimate of its thickness.

† In the Kane-Ludlow section, plate No. XI, this interval is represented by a single coal bed marked the *Alton coal.*

encountered, and it is reported that the workmen abandoned the hole from fear of suffocation and explosion before the coal bed was reached.

§ 272. The *Clermont coal bed* is the representative of the Clarion coal and the base of the lower productive coal measures proper (See § 82). It has been opened in a number of places in the Kane locality and along the Big Level road, toward Howard Hill.

The fire clay bed which is found under the *Old Kittanning camp ground*,* is in all probability the underclay of the Clermont coal bed.

On the Howard Hill road but a short distance from Kane, a number of openings have been made on the Clermont and Alton (upper) coal beds, viz. on Coon lot, opposite Oberg's house, and in several places in W. Wilkin's field. In the latter locality a shaft is said to have been sunk 8 feet, and to have encountered 19 inches of coal. The openings were visited, but their elevation or location was not determined. The two beds can be easily distinguished from the fact that pieces of the JOHNSON RUN SANDSTONE are invariably found above the *Alton coal*, while the overlying strata of the upper bed are shales.

In no locality in Wetmore did I see the Clermont coal bed of sufficient thickness and purity to prove a workable commercial coal. In fact, judging from the most reliable information which I could obtain from parties who have prospected in Wetmore, I am disposed to believe that there is little or no coal in this township which can be mined at a profit and used as a desirable fuel.

§ 273. The JOHNSON RUN SANDSTONE has a character not unlike that which it is found to possess generally throughout the county. It is possibly more ferruginous, and contains a greater number of plant remains in the vicinity of Kane than elsewhere. The iron gives the stone quite a beautiful pink and yellowish color, making it a desirable facing stone in building. It has been cut into along the

*This camping ground is located in the midst of the dense hemlock forest north of General Kane's house. It was on the Kittanning trail, and the Indians broke their journey by camping here at night.

railroad in front of the Thomson Mountain house, and on the Clarion summit. I have estimated the thickness of the rock as 50′. In Mr. Dalson's section constructed in Hamlin township, (page 171,) but which represents also the strata of Wetmore, the thickness assigned to the JOHNSON RUN rock is 40′, (strata 12 to 21 inclusive, page 171.)

§ 274. The *Alton coal group* has been estimated as 15′ thick, composed of shale, slate, and fireclay, containing 2 or 3 locally developed coal beds.

Besides being opened on the Howard Hill road, one of the beds has been mined at Pete Kalson's (?) opening, beyond the Swedish settlement to the southwest of Kane. As much as 500 bushels of coal is reported to have been mined at this opening, in one winter. The elevation of the coal is about 40′ below the Kane RR. station. The same coals have been tested in a number of places on the summits to the southeast and northwest of Kane, but at none of the openings were the beds found in a workable condition.

It cannot be expected that any of these coal beds will ever be mined, except by the farmers and lumbermen in the immediate vicinity.

§ 275. The KINZUA CREEK SANDSTONE (page 54) is found in loose blocks scattered along the edges of the plateaux and over the hill slopes generally throughout the township. The rock is 45′ thick, and in general character is not unlike the overlying Johnson run rock. In fact it is only with the greatest difficulty that the three sandstone members of the Pottsville Conglomerate, No. XII, can be distinguished from one another.

The thin coal bed which is frequently found interlocked in the Kinzua creek sandstone has never been observed in the township. (Page 55.)

§ 276. The *Upper Marshburg coal bed* and coal slates and shales are distinctly marked by a change in the slopes of the hillsides. On West run to the southwest of Kane, the bottom of the Marshburg strata was located about 25′ above the run, at the road crossing. I have never seen the face of the coal bed, and cannot make a final statement as

to its condition and value. It is, without doubt, a worthless bed, for it has never proved workable at any of its openings elsewhere. The thickness of the interval varies from 5 to 10 feet.

§ 277. The OLEAN CONGLOMERATE, (page 56,) has a more conglomerate character than the other two members of the Pottsville. Aside from this one feature, it does not differ essentially. Its average thickness has been estimated as 60′.

The Hukill* and Coburn dry holes pierced the lower part of the Olean rock, so that its relative position to the lower formations in the township has been definitely determined. It is difficult to obtain the exact position of the conglomerate, from the fact, that its outcrop is invariably covered by the broken down fragments of the Kinzua creek and Johnson run rocks.

On the road† from Wetmore station to Blisses, near the junction of Kinzua creek with the south branch, the OLEAN CONGLOMERATE is found at an elevation of 1890′ in loose blocks. The rock consists of a coarse-grained yellow and gray sandstone with occasional pebbles. The bottom of the OLEAN is probably only a few feet below this elevation; the height of this horizon on the RR., but a short distance southeast of the station, is 1868′.

The divide between Wildcat run and south branch Kinzua creek, is 2015′ at a point about 2½ miles from the station. It is underlaid by the OLEAN and the KINZUA CREEK SANDSTONE, together with a portion of the JOHNSON RUN SANDSTONE.

§ 278. No rock exposure was observed at the bottom of the Olean, so that I am unable to make any statement as to the probable occurrence of the lower Marshburg coal (pages 64 and 193.)

§ 279. The SUB-CONGLOMERATE ROCKS in Wetmore, have been drilled through by a number of oil prospectors, and their character is shown in the records of the Coburn, and Ernhout and Taylor, No. 2 dry holes given below.

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* Hamiltown township.

† One mile from RR. station.

§ 280. *Coburn dry hole.*—This well is located on an east branch of Dalson run, and a little over 1½ miles due north of Sergeant station, on the P. and E. R. R. (See plate XI.)

	Well mouth above ocean, in feet,		=1900
1.	Conductor,	20 to	20=1880
2.	White pebbly sand,	50 to	70=1830
3.	Gray slate,	32 to	102=1798
4.	Sand, (show of oil,)	46 to	148=1752
5.	Slate,	30 to	178=1722
6.	Sand, (show of oil,)	34 to	212=1688
7.	Hard shell and sand,	183 to	395=1505
8.	Red rock,	200 to	595=1305
9.	Gray sand containing gas,	15 to	610=1290
10.	Red rock,	100 to	710=1190
11.	Gray slate and shell,	530 to	1240= 660
12.	Hard sand,	16 to	1256= 644
13.	Gray slate,	124 to	1380= 520
14.	Sand,	35 to	1415= 485
15.	Gray slate,	63 to	1478= 422
16.	Sand,	15 to	1493= 407
17.	Gray slate,	40 to	1537= 367
18.	Sand, (smell of oil,)	20 to	1557= 347
19.	Sand, (nearly solid,)	200 to	1757= 147
20.	Gray slate,	38 to	1795= 109
21.	Sand,	15 to	1810= 94
22.	Gray slate,	30 to	1840= 64
23.	Sand,	40 to	1880= 24
24.	Gray slate and shells,	64 to	1944— 40
25.	Brown sand containing oil,	9 to	1953— 49
26.	Gray slate and shells,	15 to	1968— 64
27.	Sand, (BRADFORD OIL PRODUCING SAND,)	70 to	2038— 134
28.	Slate,	55 to	2093— 189
29.	Slate and sand,	170 to	2263— 359

Drilling was commenced on this well during the first week of May, 1879 ; on the 25th of July the drill was down to a depth of 1968. It was completed during the month of August. All surface water was excluded from the hole by a casing which went to a depth of 357 feet. A show of petroleum is said to have been found in strata Nos. 4 and 6 which probably conjointly represent the SUB-OLEAN CONGLOMERATE.

Stratum No. 9, near the center of the red Catskill, is said to have contained gas.

Brown sand, stratum No. 25, was reported to have contained some oil. After drilling was stopped, an effort was made to *plug* the hole at about 1970 feet in order to shut

off the gas coming from 2093 feet, and test the sand from 1944 to 1953 feet, this however failed. The casing was finally drawn, and the hole abandoned as *dry*.

From a comparison of this record with those of the Wilcox wells, I have concluded that stratum No. 27 is the representative of the BRADFORD OIL PRODUCING SAND.

The record of the Coburn well was not kept with sufficient care to warrant an acceptance of all the facts reported. I believe that an excessive thickness has been assigned to the sand beds.

For convenience of comparison with other records in McKean and Elk, I have grouped these strata into the following formations:

DRIFT AND OLEAN CONGLOMERATE, (strata 1 and 2,) . . .	70′
MAUCH CHUNK No. XI, AND POCONO No. X, (3 to 7 incl.,) .	825′
Red Catskill No. IX, (8, 9, and 10,*)	260′
UPPER CHEMUNG No. VIII, (11 to 26 inch,)	1313′
BRADFORD OIL SAND No. VIII, (27,)	70′
Lower Chemung No. VIII, (28 and 29,)	225′
Total, ...	2263′

§ 281. *Ernhout and Taylor Well, No. 2.*

Owned by Ernhout and Taylor, and situated in the south-eastern corner of warrant 3215, Wetmore township, McKean county, about one mile north of well No. 1. Tract formerly part of McKean and Elk Land and Improvement Company's lands.

Drilling commenced March 12, 1878, mineral water "vein" struck at a depth of 1990 feet May 9. The well was afterwards drilled 10 feet deeper through a dark fine (coffee grounds) sand strongly impregnated with oil.

Record reported by Mr. M. M. Schultz, of Wilcox.

* All of stratum No. 10 is not included in this estimate, as it seems quite probable that the drillers have located the bottom of No. 10 too low. This error is often made, from the fact that after passing through a red rock, unless the greatest precaution is taken, the sand pumpings of the rocks underneath the red stratum will be colored by fallen down and pounded up portions of the red rock.

	Well mouth above ocean in feet (Bar.),		=	1730
1.	Loam and sand,	40 to	40=	1690
2.	Gray slate,	85 to	125=	1605
3.	Shells,	10 to	135=	1595
4.	Gray slate,	65 to	200=	1530
5.	Gray slate and shells,	105 to	305=	1425
6.	Red shale,	10 to	315=	1415
7.	Sand and shells,	40 to	355=	1375
8.	Red shale,	125 to	480=	1250
9.	Shells,	30 to	510=	1220
10.	Red rock,	50 to	560=	1170
11.	Gray slate,	30 to	590=	1140
12.	Red shale,	55 to	645=	1085
13.	Gray slate,	175 to	820=	910
14.	Hard sand shells,	80 to	900=	830
15.	Sand shell,	100 to	1000=	730
16.	Sand,	75 to	1075=	655
17.	Red rock,	5 to	1080=	650
18.	Red rock, "pale,"	5 to	1085=	645
19.	Gray slate,	85 to	1170=	560
20.	Red rock,	5 to	1175=	555
21.	Soft, muddy, gritty, slate,	130 to	1305=	425
22.	Gray slate,	80 to	1385=	345
23.	Light gray slate,	10 to	1395=	335
24.	Sand shells,	10 to	1405=	325
25.	Sand, smell of oil,	10 to	1415=	315
26.	Sand containing heavy gas "vein,"	2 to	1417=	313
27.	Sand,	5 to	1422=	308
28.	Gray slate,	48 to	1470=	260
29.	Sand and shells,	85 to	1555=	175
30.	Dark and light gray slate,	210 to	1765=	— 35
31.	Sandy slate,	45 to	1810=	— 80
32.	Hard gray sand,	5 to	1815=	— 85
33.	Slate,	65 to	1880=	— 150
34.	Dark brown sand,	10 to	1890=	— 160
35.	Soft gray slate,	90 to	1980=	— 250
36.	Dark sand strongly impregnated with oil,	10 to	1990=	— 260
37.	Dark fine sand (coffee grounds) containing oil,	10 to	2000=	— 270

Drilled dry. Cased,	364′
Gas,	1415′
Oil smell,	1405′
Strong smell of oil,	1890′
Strong smell of oil,	1990′
Heavy "vein" of mineral water, easily corroding the tools,	1990′

The record of this well does not compare as favorably with those 5 miles north of Wilcox, Sergeant township (plate XI), as others in the vicinity. The following group-

ing of the strata suggests itself after a comparison with other records in this part of the county.

DRIFT,	40′
POCONO No. X (2 to 7 inch),	315′
RED CATSKILL, No. IX (8 to 12 inch),	290′
CHEMUNG, No. VIII (13 to 35 inch),	1335′
BRADFORD OIL SAND (?) (36 and 37),	20′
Total,	2000′

Oil not having been found in this well in paying quantities the casing was drawn, and water from the fresh water "veins" permitted to flow into the hole. The gas threw out of the well water at regular intervals to a height of 125 feet, more or less.* Shortly after the casing was drawn a wooden plug was inserted into the upper part of the well and partially filled the hole. After this was done the well spouted every eleven minutes, the eruption lasting for two minutes. During 1878 the column of water and gas rose above the top of the derrick (70 feet), and after several pulsations would fall and almost cease to spout, when it would suddenly rise again repeating the action and vanishing entirely at the end of two minutes.

From the character of this well and its close proximity to the Mountain-House at Kane, I have named it the Kane Geyser Well.

On the afternoon of July 15, 1879, Mr. A. W. Sheafer (aid) made a series of observations, commencing at 7 minutes and 45 seconds past 4, extending over one hour, to 8 minutes and 45 seconds past 5. The results of his observations he has embodied in the following table:

*See paper which I read before the Society, Sept. 21, 1877, on the "Wilcox Spouting Water Well." The action in these two wells is similar.

Record of Water-spouts, Kane Geyser Well, July 15th, 1879.

NUMBER OF OBSERVATION.	Slight explosion heard in pipe.	Interval.	Water commences to run out.	Interval.	Attains maximum height.	Height.	Water column rises again.	Interval.	Attains maximum height.	Height.	End of discharge.
1, ...	4. 7'.45''	2'.30''	4.10'.15''	25''	4.10'.40''	80	. . . .	. . .	4.11'.45''	80	4.12'.10''
Interval, ...	11'.15''	. . . .	11'.15''	. .	11'.20''	. . .	. . . .	. . .	11'.15''	. . .	11'.20''
2, ...	4.19'	2'.30''	4.21'.30''	30''	4.22'	85	4.22'.30''	30''	4.23'	95	4.23'.30''
Interval, ...	11'.15''	. . . .	11'.30''	. . .	11 .15'	. . .	11'.45'	. . .	11'.20''	. . .	11'.15''
3, ...	4.30'.15''	2'.45''	4.33'	15''	4.33'.15''	80	4.34'.15''	5''	4.34'.20''	80	4.34'.45''
Interval, ...	11'.15''	. . . .	11'.15'	. . .	11'.25''	. .	11'.15''	. . .	11'.25''	. . .	11'.25''
4, ...	4.41'.30''	2'.45''	4.44'.15''	25''	4.44'.40''	90	4.45 .30''	15''	4.45'.45''	95	4.46'.10''
Interval, ...	11'.30''	. . . .	11'.20'	. . .	11'.20'	. . .	11'.10''	. . .	11'.05''	. . .	11'.20''
5, ...	4.53'	2'.35''	4.55'.35''	25''	4.56'	75	4.56'.40''	10''	4.56'.50''	90	4.57'.30''
Interval, ...	11'.15''	. . .	11'.15'	. .	11'.20''	. . .	11'.20''	. . .	11'.30''	. . .	11'.15''
6, ...	5. 4'.15''	2'.35'	5. 6'.50''	30''	5. 7'.20''	75	5. 8'	20''	5. 8'.20''	85	5.8'.45''

The sequence of events is as follows (observation No. 2):

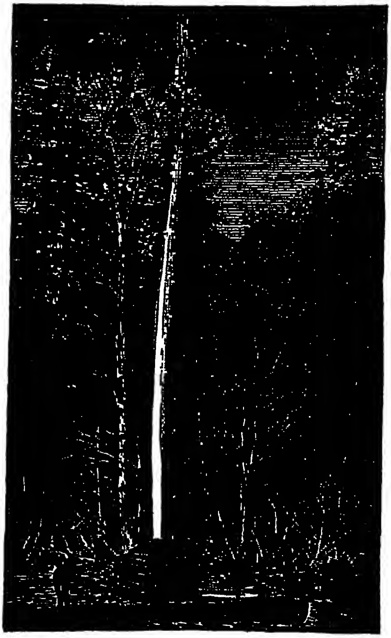
At 19 minutes past 4 o'clock a slight explosion was heard in the *drive-pipe*, after an interval of 2 minutes and 30 seconds water commenced to run out of the hole, in 30 seconds the water column reached its maximum height of 85 feet; the column then commenced to diminish, and after an interval of half a minute commenced again to rise, and in 30 seconds reached a height of 95 feet; after a half minute the flow of water ceased and nothing but gas came from the well for a space of 6 minutes and 45 seconds. At 30 minutes and 15 seconds past 4, commenced the action recorded in observation No. 3.

On the evening of July 31, Mr. Sheafer again measured two water columns, which went to a height of 120 and 128 feet, respectively. On the evening of August 2, I measured four columns in succession, and the water was thrown to the following heights: 108, 132, 120, and 138 feet.

In winter these columns become encased in ice, forming huge translucent chimneys.

The accompanying cut was made from a photograph which I sent Prof. Dana, who first published it in his Manual of Geology (3d ed., page 752).

The cause of the water spouts is readily explained (see description of Wilcox Spouting Water Well, page 151). The water flows into the well on top of the gas until the pressure of the confined gas becomes greater than the weight of the superincumbent water, when an explosion takes place, and a column of water and gas is thrown out of the well.



Kane Geyser Well.

§ 282. *Running section.— Wetmore station to Kinzua, Kinzua township, Warren county.**

Bar. elevation.	DESCRIPTION.	LOCALITY.
1804'	. . . .	Wetmore station, P. and E. R. R.
1745	. . . .	Bridge over Two Mile run.
1810	Loose gray SS.	
1844	Loose, white and yellow SS. and conglomerate.	
1890	Large SS. rocks, ...	1 mile north of Wetmore.
1915	. . . .	Plank bridge over branch of Two Mile run.
2015	Soil sandy, ...	Summit.
1860	Soil sandy.	
1805	Large SS. rocks.	
1865	. . . .	Bridge over brook at G. Bliss', Hamilton township.
1800	. . . .	Forks of the Kinzua, Hamilton twp.
1300	. . . .	Bridge over the Kinzua, below forks.
1385	. . . .	Junction of roads at bridge.
1375	. . . .	Road at school-house.
1350	. . . .	Road to saw-mill.
1310	. . . .	Brook.
1360	Shaly soil, ...	Top of rise beyond brook.
1365	. . . .	Brook.
1380	Shaly soil, ...	Summit beyond.
1340	Top of exposure, red and gray shales.	
1320	Bottom, do.	
1270	. . . .	Kinzua at exposure.
1335	. . . .	Junction with road to Morrison's saw-mill.
1260	. . . .	Dam at saw-mill.
1355	Red shales.	
1265	. . . .	Bridge over Chappel fork.
1275	. . . .	Oil well to left of road on creek bank.
1295	. . . .	Oil well on Bartholomew's farm.
1255	25' of olive and green shales and SS. very much weathered, containing fossils.	
1230	. . . .	Bridge over the Kinzua, Warren co., near McKean co. line.

*See § 160, page 121.

Chapter XIV.

Introduction.

§ 283. The second group of the townships in McKean, or those containing no coal of commercial value, are embraced in the following list:

1. Corydon,
2. Bradford,
3. Otto,
4. Eldred,
5. Ceres,
6. Annin,
7. Hamilton,
8. Keating,
9. Liberty.

Of these Bradford, Otto, Keating, together with Lafayette already described, have recently come into more or less prominence on account of the extensive oil territory which they contain. As this present report deals with the coal rather than the petroleum interests, these townships which include the least important coal areas in the county are described in the present chapter in the above order.

1. Corydon Township.

§ 284. Corydon occupies the extreme northwestern corner of the county. It adjoins Corydon township, Warren county on the west.

Its topography, in its general features, is not dissimilar to that of Lafayette. It stands next to this township in the extent of its plateaux.

The drainage of the township all flows to the west through Corydon and Sugar creeks.

The highest point is in the northeastern part, between Willow creek and Quaker run, where an elevation of nearly 2200 feet is attained. The lowest point is where Sugar run

crosses the Warren-McKean line at an elevation of something under 1300 feet.

Corydon may be called the *Barren* township of the county as it seems at present to contain, in proportion to its size, more wooded, barren and waste land than any other.*

§ 285. Most of the summits are capped by one of the sandstone or conglomerate members of the Pottsville, No. XII. Several coal openings have been made in different parts but as far as could be accertained they have been on one of the Marshburg or Alton beds which are locked in the conglomerate series.

§ 286. According to local authorities the coal area in the northeastern corner (see county geological map) is said to be of several thousand acres in extent and to contain good workable coal beds. The facts as far as known do not warrant any such assertion. It is very questionable whether any coal can ever be profitably mined in the township.

§ 287. Very few facts have been determined from which an estimation of the dip of the strata could be made. The elevation of the top of a flat pebbled rock which was taken to be the representative of the SUB-OLEAN CONGLOMERATE at Corydon, in Warren county on the Allegheny river, is 2109′ above tide, this would make the bottom of the OLEAN CONGLOMERATE about 2175′.

Near the county line crossing of the Kinzua creek, the top of the SUB-OLEAN, is *1920′*, and the bottom of the OLEAN *1975′*. Under Marilla summit, the elevation of this same geological horizon is *2150′*, and at Marshburg 1975′; from these elevations, I have estimated the general average dips per mile of the base of the POTTSVILLE CONGLOMERATE.† The dip of the Chemung rocks, immediately associated with the BRADFORD OIL SAND, must be about the same, as I believe the interval between the conglomerate and sand in Corydon, maintains a constancy of thickness.

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*The number of houses and shanties in the township could almost be counted on one's fingers.

† Olean conglomerate.

Table of dips.

From	To	Distance in miles.	Direction.	Average rate of dip per mile.
Corydon, .	Marilla Summit, ...	10	S. 80° E.,	2½′
Corydon, .	Kinzua creek, (county line crossing,)	11½	South, . .	17½′
Corydon, .	Marshburg, ...	14	S. 48° E.,	14′

§ 288. The section of outcropping rocks in the township, extends from the JOHNSON RUN SANDSTONE, down to the upper Chemung rocks found in the valleys of Sugar run and Corydon creek; in all something over 900′. The records of the oil wells would extend this downward to below the BRADFORD SAND, but none of the well records have been reported.

§ 289. No productive oil territory has yet been proved in the township, although a number of tests have been made.

2. Bradford Township.

§ 290. This has become one of the best known and important townships in the county, on account of its containing the greater portion of the Bradford Oil District.

It is bounded on the west by Corydon, and on the North by the State of New York. With the exception of a very small area in the southeastern and northwestern corners, it is drained by the Tuna creek, which flows north, and empties into the Allegheny river at Carrolton Junction. The greatest elevation measured, is that of Mount Raub, which attains a height of 2225 feet. The lowest point is where the Tuna creek crosses the State line, at an elevation of about 1415 feet.

§ 291. The higher summits are capped by one of the sandstone members of the Pottsville conglomerate. These are usually either KINZUA CREEK SANDSTONE, or the OLEAN CONGLOMERATE; it is only in the southern and western parts of the township, that small and limited areas of the JOHNSON RUN SANDSTONE with the underlying *Alton coal beds* are to be found.

The dip of the conglomerate capping the hills and the oil sand 1800 feet below, is coincident. This must necessarily result from the fact that there is no perceptible thickening of the included formations. The recorded dips have been estimated from observations both on the conglomerate and oil sand.

Table of Dips.

From	To	Distance in miles.	Direction.	Average rate of dip per mile.
Olean, Rock City, . . .	Tarport, ...	9.	S. 66° W., . . .	5½′
Tarport, . . .	Bradford, . . .	1.25	S. 55° W., . . .	13′
Bradford, . . .	De Golier, . . .	8.	S. 8° W., . . .	12½′
De Golier, . . .	Lewis Run, . .	2.25	S. 8° W., . . .	37′
Bradford, . . .	Marshburg, . .	9.	S. 40° W., . . .	21½′
Bradford, . . .	Marilla Summit,	6.	N. 80° W., . . .	3′
Tarport, ...	S. E. cor. of twp.	7.5	S. 40° E., . . .	14′

The minimum dips are in the northern part of the township, from Olean Rock City, which is in Cattaraugus county, N. Y., to Bradford, to Marilla summit; while the greatest estimated dip is 37′ per mile between De Golier and Lewis run, in the southern part.

§ 292. The total thickness of the rocks, which may be studied on the outcrops and in the oil wells, is about 2,000 feet, subdivided as follows:

Pottsville, No. XII,	Johnson run SS., ...	20′±
	Alton coal group, ...	25′
	Kinzua creek SS., ...	50′
	Upper Marshburg coal, ...	—
	Olean conglomerate, ...	50′
Mauch Chunk, No. XI, Pocono, No. X,	. . . .	247′
Red Catskill, No. IX,	. . . .	250′
Chemung, No. VIII,*	. . . .	1835′±
Total,	. . . .	1977′

§ 293. No detail section has been made of the POTTSVILLE CONGLOMERATE, and the thickness of its several members

* This includes the Chemung to the bottom of the Bradford oil sand; the deeper wells would increase the length of this section 100 to 200 feet.

is estimated from the sections measured in Lafayette township.

§ 294. Considerable excitement was created at one time in Bradford over the reported discovery of a valuable coal track to the north of Marilla summit in the northwestern part of the township. The coal area is very limited, and as far as could be determined contains no beds higher than those of the Alton group. It is interesting to know that this coal patch is the EXTREME NORTHERN COAL OUTCROP of the Appalachian basin.

§ 295. The OLEAN CONGLOMERATE has a character generally throughout the township, which is typical of the formation, (page 57.) Bold exposures of the rock may be seen on either side of the Tuna valley. Immediately west of Custer City it contains immense pebble masses, and shows the identical features which are to be observed at the Olean Rock City.

§ 296. The Sub-Olean and Devonian rocks are described for this township in detail in Chapter VII and in the descriptive chapter of the Bradford Oil district, Chapter XV.

3. *Otto Township.*

§ 297. This township is directly east of Bradford. Its northern boundary is the State line.

It is drained almost exclusively by Knapp's creek, which flows into the Allegheny near Eldred. The greatest elevation instrumentally measured is the summit of the Tide Water pipe line southeast of Rixford, which is 2148′. In the northern part of the township south of the Olean Rock City, the summit attains a height of 2350.′ The lowest point in the township is where Knapp's creek crosses the eastern boundary line.

§ 298. There is no *coal* in the township, and no mineral has ever been discovered within its boundaries of economical importance other than petroleum. A greater proportion of Otto township has proved good productive oil territory * than any other township in McKean.

*See Map of the Oil Districts, McKean co., Plate XVII.

§ 299. The dip of the BRADFORD OIL SAND on a line between Olean Rock City and Rixford is 11′ per mile, south 15° west.

§ 300. The outcropping rocks extend from the KINZUA CREEK SANDSTONE capping the highest summits down to the upper Chemung strata in Knapp's creek valley.

4. *Eldred Township.*

§ 301. Eldred lies east of Otto and Keating and along the State line.

The Allegheny river flows north through the center of the township and receives within its limits numerous small tributaries the principal of which are Mix and Indian creeks and Barden brook.

The main feature of the topography is the river valley.

There is a comparatively small area of high land.

The summits on either side of the valley attain an elevation of *2200′* (more or less). The lowest elevation is where the river enters the State of New York at an elevation of 1440′±.

§ 302. No *coal* was found in the township and it is only to the west of the river that any POTTSVILLE CONGLOMERATE is found.

§ 303. The outcroping strata extend from the KINZUA CREEK SANDSTONE downward for 800′ to the upper Chemung rocks. The thicknesses of these formation range the same in Bradford, Otto and Eldred.

§ 304. Good profitable oil territory, up to this time, has only been found in the northwestern corner of Eldred.

5. *Ceres Township.*

§ 305. This township occupies the northeastern corner of the county. To the west of it lies Eldred.

A northwest and southeast divide runs through the central part. The southwestern slope drains directly into the Allegheny river, while the water to the northeast drains through Bell's and King's runs into Oswayo creek. The greatest elevation determined is *2245′*, 1 mile southwest of Glenn P. O. The lowest point in the township is 1443′, at

the northwestern corner, near State Line station on the B., N. Y. & P. R. R.

§ 306. The section of outcropping rocks in the township extends from the top of the Pocono, No. X, rocks down to the Upper Chemung, along Oswayo creek and its branches.

§ 307. It is an interesting fact to note, that this is the only township in the county where none of the strata of the COAL MEASURES occur.

§ 308. No OLEAN CONGLOMERATE was found on any of the highest summits which were visited.

§ 309. No red shale was seen which could represent the Mauch Chunk.

§ 310. The Pocono rocks (page 64) are between 250′ and 300′ thick. All the summits, as far as known, are capped by the rocks of this formation.

§ 311. The top of the Catskill No. IX is marked by a red shale band, associated with a fossiliferous limestone. This limy band may be seen on the southern side of the road to Ceres, about ¼ mile north of S. Russell, Jr.'s house. Its elevation is *2075′*. The thickness of No. IX could not be determined here, but in descending the road, in King's run valley, toward Ceres, red soil was found as low as T. Lynch's house, or 400′ below the top of the formation north of Russell's. There is quite a dip in the strata from Russell's to Lynch's, so that the formation would be much less than 400′ thick.

Along the Allegheny river in Eldred, 6 miles west of King's run, the red and gray shales of No. IX are 225′ thick, and it is hardly possible that the same rocks would be more than 250′ thick in Ceres.

On the road from Ceres to Eldred and 3½ miles southwest of Ceres, where the road crosses the east and west line between warrants 2190 and 4327, the top of the Catskill is *1996′* above tide. The red soil continues down Barden brook towards Eldred to an elevation of *1645′* near Biggen's farm.

From the same summit toward Ceres the red soil continues down to an elevation of *1720′*, in the vicinity of M. Mazera's place. The top of the Chemung near this locality

was placed at an elevation of about *1750′*, which would make the Catskill 250′ thick, more or less.

§ 312. No coal, petroleum, or other mineral of economical value was found in Ceres township.

§ 313. The following observations have been placed in the form of running sections. It was not possible to place them in the form of a vertical column, as the dip of the strata is not known, (page 122.)

§ 314. *Running Section—Ceres to Eldred.*

Bar. elevation.	Description.	Locality.
1450	. . . .	Bridge over Oswayo at Ceres.
1520	. . . .	Junction of roads.
1485	. . . .	Bridge over King's run.
1603	Olive shales.	
1720	Red soil.	
1815	Red soil.	
1920	Red and green flags and shales, 10 ft.	
1965	Red soil.	
2210	. . . .	Summit of hill south of road.
2046	Gray flaggy SS., ...	Summit of road.
2028	Green flaggy SS., 5′.	
1995	Red soil.	
1795	Red soil.	
1648	Red soil, ...	Junction of roads.
1568	. . . .	Junction of roads.
1443	. . . .	Eldred Station, (B., N. Y. & P. RR.)

§ 315. *Running Section—Turtle Point to Ceres, Ceres township.*

Bar. elevation.	Description.	Locality.
1456	. . . .	Turtle Point Station, (B., N. Y. & P. RR.)
1450	. . . .	Bridge over Rock run.

1455	Olive flaggy SS., ...	Junction of roads.
1493	. . . .	First house on left.
1510	Soil slightly red, ...	Second house.
1518		
1533	Red soil, ...	Third house.
1538	. . . .	Brook.
1559	Red soil.	
1580	Gray soil.	
1590	Red soil.	
1617	. . . .	School-house.
1665	Red soil.	
1792	Red soil.	
1835	Red shale, ...	Junction of roads.
1930	Soil slightly red, ...	T. Bly's house.
2188	. . . .	Hill N. W. of Bly's.
2230	. . . .	Hill east of Bly's.
1983	Gray soil, ...	Summit of road.
2245		
2190	Gray flaggy SS., ...	Junction of roads.
2105	Gray flaggy SS., 3 ft.	
2085	Gray shales much weathered, 10 ft.	
2075	Shales more massive. Loose pieces of fossill. Limestone.	
2070	Red shale 3'.	
2065	Olive shales 5'.	
1940	Olive shales.	
1880	Red soil.	
1680	. . . .	Road at Lynch's.
1940	. . . .	Summit to west of Lynch's.
1620	. . . .	Junction of roads.
1640	Loose pieces flat pebble conglomerate.	
1705	. . . .	School-house.
1750	Soil red, ...	Chevalier's house.
1625	Gray shales.	
1530	. . . .	School-house.
1495	. . . .	Bridge over King's run.
1520	. . . .	Junction with road to Eldred.
1520	Green flaggy SS.	
1460	. . . .	Turn in road.
1450	. . . .	Bridge over Oswayo, at Ceres.

6. *Annin Township.*

§ 316. Annin lies east of Eldred and Keating, and south of Ceres.

The drainage of the township, with the exception of a small area in the northeastern corner, is to the southwest through Newell, Rock, Annin, Two Mile, and Lillibridge creeks. This regularity in the direction of the streams is determined by the geological structure.

The highest elevation measured is *2345'*, on the summit between the head-waters of Annin and Rock creeks. The

lowest point is where Rock creek empties into the Allegheny river, at an elevation of about *1435′*.

§ 317. The northwestern portion of the township, together with those already described in this chapter, is located in the Sixth Bituminous coal basin. The central part of the township is crossed from northeast to southwest by the Smethport (Fifth) anticlinal axis.

§ 318. The strata in Annin are far from horizontal, the dips being much greater than they are in the townships forming the northern tier, and lying to the west of Annin.

The elevation of the bottom of the Red Catskill formation, No. IX, near D. C. Winship's house, in the northern part of warrant 2228, 3½ miles from Turtle Point, is *1625′*. The top of the same formation in the vicinity of J. Woods', near the head of Annin creek, is *2100′*. This would show an average southwestward dip of 80′ to the mile. There is an apparent southwest dip along Two Mile creek of about 50′ to the mile.

From the head of Lillibridge creek, southwest toward Port Allegheny there is an average dip per mile of 45′. This dip seems to be a regular one and is estimated from observations in both the Olean and Catskill strata.

Besides this southwestern dip, which seems to maintain in all the streams, there is a northwestern and southeastern dip away from the axis of the anticlinal.

§ 319. The outcropping rock section of the township extends from the Kinzua creek sandstone down to the Upper Chemung, in the Allegheny valley.

To the northwest of the Smethport anticlinal there are two small patches of Olean Conglomerate. These are matched by two similar patches on the southeast side, between Annin and Two Mile creeks. In the southeastern corner of the township, as the measures dip in toward the center of the Clermont coal basin, higher measures are found; the Kinzua creek sandstone and probably one of the coal beds of the *Alton group*, occurring on the high summit immediately north of the head of Lillibridge creek.

§ 320. No shales were seen exposed in the horizon of the Mauch Chunk, No. XI.

§ 321. The Pocono shales and sandstones, No. X, range in thickness from 250′ to 300′. Near the road forks ½ mile southeast of J. Wood's place, and near G. Kinney's farm, were exposed two red shale bands in No. X, at elevations respectively of *2240′* and *2290′*. The bottom of the formation is about 140′ below the lower band. A third, and still lower red band was found in the southeastern corner of the township, at an elevation of *2080′*, or 80′ above the bottom of the formation.

The Lower Pocono dips in this locality to the southeast, at an average rate of 100′ to the mile. This estimate is based on the position of the red bands.

The summit to the northeast of F. H. Arnold's house, is *2210′* high, and is capped by the upper layers of the Pocono. Immediately above his house, a thin red shale band was found at an elevation of *1970′*; this is without doubt, the lower part of the Pocono.

§ 322. The Catskill formation No. IX, is about 300′ thick in the southern part of the township.

§ 323. Annin up to the present time has produced no mineral of economical value.

§ 324. *Running section from Turtle Point up Annin creek, to Potter county line.*

Bar. elevation.	Description.	Locality.
1456′	. . . .	Turtle Point station, (B., N. Y. and P. RR.)
1465	Green shales, ...	Junction of roads.
1550	. . . .	Bessies'.
1565	Red soil.	
1624	. . . .	Winship's,
1670	. . . .	Cooper's saw-mill.
1815	Red soil, ...	Top ridge.
2280	Fine-grained gray flaggy SS. . .	
1745	Red soil, ...	M. E church.
1728	Red soil, ...	Cross Roads.
1825	Red soil.	
2000	Green shales.	
2025	Green shales, 1′.	
2200	Soil slightly red.	

2245	Gray, gritty, flaggy micaceous SS., loose, ...	
2340	. . . .	Summit of road.
2270	Red soil, green flaggy SS. . . .	
2260	Green shales.	
2290	Red shale.	
		Junction with road down Two Mile run.

7. *Hamilton Township.*

§ 325. This township joins Kinzua and Sheffield townships, Warren county, along the McKean-Warren line. It is bounded on the north by Corydon township, Warren and Corydon township, McKean. In 1879 the southern boundary line was readjusted and a portion of northwestern Wetmore enclosed within its limits.

It is drained by Kinzua creek and its branches and Two Mile run, a branch of Tionesta creek flowing into it at Sheffield. The general direction of Kinzua creek has been determined by the *Kinzua-Emporium cross anticlinal axis* (page 38), which crosses the township from east to west.

§ 326. The topography in its general features is not unlike that of Lafayette to the east and Wetmore to the south. The highest summit in the township is in the northern part, known as Paine's summit, which attains an elevation of *2050'* to *2100'*. The lowest point is the Kinzua creek crossing of the county line at a height of *1240'*± above tide.

§ 327. The township lies entirely in the *Sixth coal basin.* Dalson thought that the township was crossed by several subordinate anticlinal axes having a general northeast and southwest direction.* In the course of my examinations none of these axes were found; the Kinzua-Emporium axis, lying in quite a different direction, being the only one that was located.

§ 328. The dip of the coal measures in the township is away from the Kinzua-Emporium axis. Beside these dips

* Stated on the authority of Maj. Gen. Thomas L. Kane.

there is a general progressive dip throughout the township to the southwest.

Sufficient facts were not obtained to estimate the local dips.

§ 329. The vertical section of rocks outcropping in the township extends from the over shales of the Clermont coal bed down 935′ to the Upper Chemung shales and sandstones; they may be sub-divided as follows:

LOWER PRODUCTIVE COAL MEASURES No. XIII and POTTSVILLE CONGLOMERATE No. XII,	200′±
MAUCH CHUNK, No. XI, POCONO, No. X,	850′
CATSKILL, No. IX,	260′
UPPER CHEMUNG, No. VIII,	125′+
Total,	935′

The record of the Hukill and Davis well would extend this section downward 1225′ further so that we have a general knowledge of nearly 2200′ of the rocks in the township.

§ 330. The highest strata have been developed on Coal knob lying between the headwaters of Mud Lick, Wild Cat and Two Mile runs. Here several coal beds have been tested and from their relation to the Olean Conglomerate they are without doubt the Clermont and Alton group coals. No openings have been made where the face of the coal beds could be seen but judging from report the coal which has been found is all of an inferior quality.

The only summits where we can ever hope to find these beds are between Two Mile run and Kinzua creek. Paine's summit is capped by the Kinzua creek sandstone. None of the tests made here have proved the existence of a workable bed in the Alton group.

§ 331. Mr. Chance in the summer of 1877 constructed a section at Great Bend on the Allegheny river immediately west of the McKean-Warren line. The rocks are beautifully exposed and the section was constructed with great care, so that it can be taken as a remarkably perfect interpretation of the structure of this region.*

*Mr. Chance believes that the section is only true for the precise locality, and would be different in detail at a comparatively short distance away.

Kinzua or Great Bend Section.

Coal Measures and Pottsville Conglomerate, No. XII.

	Summit Coal Hill Knob, above ocean,		2154′
1.	Concealed; soft measures,		8′
2.	SS., hard, massive, coarse, loose-grained (about),		20′
3.	Concealed; soft measures,		25′
4.	*Coal;* reported thickness,		2′
5.	Concealed; soft measures,		25′
6.	*Coal (cannel)*, overlaid by slate,	3′ 4″	
7.	Fireclay, (?)	7′ 0″	14′
8.	*Coal (bituminous)*,	4′ 0″	
9.	Fireclay, about		2′
10.	Concealed, SS. (reported) and soft measures,		61′
11.	SS., coarse and massive,		20′
12.	Concealed; soft measures, with *Quaker Hill coal*,		62′
13.	Conglomerate, pea to hazelnut,	10′	
14.	Coarse conglomeritic SS., with some conglomerate,	15′	
15.	Conglomerate, pea to hazelnut,	15′	77′
16.	Conglomerate and conglomeritic SS., in thin layers,	33′	
17.	Conglomerate, hazelnut to egg,	4′	
	Total Coal Measures and Conglomerate, No. XII,		316′

Pocono, No. X, Catskill, No. IX, (?) and Chemung, No. VIII.

18.	Concealed; soft measures,	24′
19.	SS., massive, coarse-grained,	32′
20.	Shale, soft, olive, with sandy layers 1″ to 6″ thick,	51′
21.	SS., dark, slaty, thin-bedded, fine-grained,	5′
22.	Shale, sandy, underlaid by sandy slate, and containing some thin sand-beds,	39′
23.	SS., slaty, thin-bedded, fine-grained, some shale,	6′
24.	Shale, with a few beds of slaty SS., 6″ to 1′ thick,	41′
25.	SS., slaty, fine-grained,	3′
26.	Shale, bluish, sandy and slaty,	17′
27.	SS., hard, thin-bedded, slaty, bluish-gray,	5′
28.	Slates, sandy beds $\frac{1}{16}$″ to $\frac{1}{2}$″ thick, dark-gray,	21′
29.	SS., grayish, slaty, false-bedded and fine-grained,	13′
30.	Slate and shale,	4′
31.	SS., slaty, thin-bedded,	5′
32.	Slate, sandy, with dark slaty shale, beds 3″ to 18″ thick,	12′
33.	Red and greenish sandy shale,	3′
34.	SS., hard, massive, fine-grained, grayish,	4′
35.	SS., flaggy, fine-grained, grayish,	4′
36.	SS., massive, fine, loose-grained,	9′
37.	Shales, soft, olive, clayey near bottom,	43′
38.	Red sandy shale,	2′
39.	Shale, sandy, olive, and blue,	9′
40.	SS., hard, massive, grayish, iron-stained,	10′

41. SS., hard, flaggy, false-bedded,		2′
42. SS., hard, massive,		2′
43. Shale, bluish, olive,		3′
44. Concealed (soft),		62′
45. Shale, soft, bluish, a few hard bands,		15′
46. SS., flaggy, blue,		1′
47. Sandy shale, blue,		1′
48. SS., hard, blue,		1′
49. Shale, blue, iron-stained,		9′
50. SS., massive, fine-grained, hard, oxide of manganese spots,	3′	18′
51. SS., false-bedded, yellowish-gray,	7′	
52. SS., massive, hard,	2′	
53. SS., coarse-grained, iron-stained, (containing sanguinolites),	3′	
54. SS., pebbly, pebbles size of wheat,	2′	
55. SS., thin-bedded, fine-grained,	1′	
56. Shale, olive to chocolate, concretionary,		27′
57. Concealed from 26′ to 45′,		26′±
58. SS., shaly, greenish-gray, mixed with red,		18
59. Concealed, softer measures,		11′
60. SS., or sandy shale, greenish-gray and red,		10′
61. Shale, olive and brownish,		34′
62. SS., thin-bedded, flaggy (6′ to 8′),		8′
63. Shale, dark,		15′
64. Spirifer band,		1′
65. Shale, soft, olive and chocolate color,		8′
66. Shale, dark and slaty, breaking into acicular fragments,		6′
67. Concealed to level of Kinzua creek,		6′
Total Nos. X, IX (?), and VIII,		646

§ 332. The details of the coal measures, in the upper part of the section, show a number of essential differences from the sections in Lafayette and Wetmore. These differences cannot be ascribed to errors of measurement or interpretation of the structure, as in each case the rock succession is distinctly marked and there is no mistaking either the thickness or position of the individual strata. They show an unquestionable change in the conditions under which the sediments were made.

The bituminous coal bed (stratum No. 8) near the top of the section is probably the representative of the Clermont bed; if so, there is an unusual occurrence of two coal beds (strata Nos. 4 and 6) immediately above it. This bed (No. 8) is 222′ above the bottom of the Olean Conglomerate (strata Nos. 13 to 17 inclusive).

In Wetmore the *Clermont bed* is 180′ above the bottom of the same conglomerate, while in Lafayette, the distance between the same two horizons is 203′, (page 189.) If this "*4 foot bed*" is the representative of the *Clermont*, there is a thickening in the POTTSVILLE CONGLOMERATE in a west and northwest direction.

§ 333. The upper part of the Great Bend section (above stratum 8,) resembles in almost every feature the character of the western McKean sections above the top of the KINZUA CREEK SANDSTONE. If such a comparison is possible, then coals 4, 6 and 8 would represent the Alton group coals; in this latter case there would have to be a still greater thickening of the POTTSVILLE CONGLOMERATE than that which we have suggested on the basis that coal No. 8 is the CLERMONT.

§ 334. There is no mistaking the fact that the SEVENTY-SEVEN FOOT ROCK is the Olean conglomerate, since I have traced the latter rock directly through Hamilton, west to Great Bend. Although there is a considerable dip to the rock here, its horizon is distinctly marked by bold outcrops. The bottom of the OLEAN along the county line, immediately north of Kinzua creek is *1975′*; while at Great Bend, 4 miles a little north of west of this point it is 1838′, showing an average dip toward Great Bend of 35′ to the mile.

§ 335. The SUB-OLEAN CONGLOMERATE (stratum 19,) is 24′ below the Olean. Along the county line, several careful measurements were made of this interval, and it ranged from 40′ to 55′. The thickness of the Sub-Olean is 32′.

§ 336. A fine exposure of Sub-Olean conglomerate can be seen at Ludlow station. Here the rock has a typical character, (page 66,) and is from 40′ to 45′ thick. The top of the conglomerate is 116′ above the railroad track at the station.

§ 337. Mr. Chance believes that the Catskill formation No. IX, and the lower part of the Pocono No. X, is absent from the section, and that the top of the Chemung rocks lies but a short distance below the bottom of the Pottsville No. XII. I believe that although there are but slight indications of any red shale in the section, the Catskill forma-

tion is none the less represented by the gray measures which occupy that portion of the section where we might expect to find red shales. For, in the Hukill and Davis well 260′ of red shales are reported to have been drilled through. The top of the red shale is 343′ below the bottom of the OLEAN CONGLOMERATE (Plate XI). This well is not more than 7 miles southeast of Great Bend. The absence of the Catskill at the latter place would necessitate a greater change in the stratigraphy than the facts suggest.

It seems most probable that the top of the Catskill is marked by the red shale band, stratum No. 38. I have come to this conclusion from a comparison of the section with facts gathered along the Kinzua valley.

Hukill and Davis Well.

§ 338. This well is located on section 175 in the western part of warrant 2597, Hamilton township. It is a little over 1½ miles northeast of Ludlow station, on the P. & E. RR.

The drilling was contracted for by J. M. George, Esq. Operations were commenced Sept. 23, and completed Nov. 4, 1878. The record was kept with a great deal of care, and I believe the facts which were reported are accurate. The detail of the record is not as great as it should be to indicate the smaller changes in the structure from the Wilcox wells northwest toward Warren.

Record.

OLEAN CONGLOMERATE No. XII.			
Well mouth above ocean, in feet,			1846
1. Clay,	23 to	23=	1823
2. White sand rock,	25 to	48=	1798
MAUCH CHUNK No. XI AND POCONO No. X.			
3. Sandy shale and slate,	343 to	391=	1455
CATSKILL No. IX.			
4. Red rock,	60 to	451=	1395
5. Shale and slate rock,	160 to	611=	1235
6. Red rock,	40 to	651=	1195

CHEMUNG No. VIII.

7.	White slate,	879 to 1030=	816
8.	Dark slate and shale,	90 to 1120=	726
9.	Purple sandy slate,	40 to 1160=	686
10.	Soft brown slate,	60 to 1220=	626
11.	Slate and hard white shale,	200 to 1420=	426
12.	Sandy shale and slate,	180 to 1600=	246
13.	White sand rock, (show of oil,)	18 to 1618=	228
14.	Slate,	55 to 1673=	173
15.	Sand shale and slate,	22 to 1695=	151
16.	Soft slate,	161 to 1856=	— 10
17.	Gray sand,	10 to 1866=	— 20
18.	Black slate,	84 to 1950=	— 104
19.	Fossil shale,	7 to 1957=	— 111
20.	Hard slate and shale, (BRADFORD OIL SAND, (?))	54 to 2011=	— 165

The well was cased dry at 360′. The only show of oil was reported to have been found in the white sand rock, stratum No. 13. This rock the drillers supposed to be the representative of the so-called *second sand* at Bradford.

Mr. George thought that the *gray sand* stratum No. 17 was the Bradford producing sand. I believe this sand is too high in the section, but still it may be a fairer comparison than that which I have suggested in the record.

§ 339. *Running section from Ludlow station to Morrison's saw-mill, on Kinzua creek, Hamilton township.*

Bar. elevation.	DESCRIPTION.	LOCALITY.
1603′	. . . .	Ludlow station, (P. & E. R. R.)
1548	. . . .	Bridge over Two Mile run.
1733	Loose SS. and conglomerate, . .	Hill north of Ludlow.
1862	SS. and small pebble conglomerate.	
1926	. . . .	Forks of road 1¾ miles from Ludlow.
2009	. . . .	Road to Bliss'.
2064	. . . .	Summit of road 3 miles from Ludlow.
1970	SS. yellow and gray, coarse-grained.	
1900	Hard gray SS.	
1813	Flat and round pebble conglomerate, loose.	

1748	. . . .	Brook crossing, 4 miles from Ludlow.
1553	. . . .	Brook crossing, 4½ miles from Ludlow.
1515	Red soil.	
1427	Red soil, Olive shales 2′.	
1333	. . . .	Bridge over Mud Lick Run.
1265	. . . .	Bridge over the Kinzua, at Morrison's saw-mill.

8. *Keating Township.*

§ 340. Keating is bounded on the west by Lafayette and Bradford, and lies to the south of Bradford, Otto and Eldred.

It is drained by Potato creek and its branches, the two principal of which are Cole creek and Marvin creek. The topography resembles more nearly that of Lafayette, than any other township in the county.

The highest point in the township is Prospect Hill, which is *2500′*, (page 19.) This hill is not only the highest in McKean, but is the greatest height in Pennsylvania, west of the Fifth Bituminous Coal Basin. The lowest point is where Potato creek crosses the northern line at Frisbee, at an elevation of about 1460′.

§ 341. The township is located in the Fifth and Sixth Bituminous Coal Basins; the southeastern corner being crossed by the Smethport (fifth,) anticlinal axis, which separates the two coal basins. The southeastern corner lies directly over the axis of the Clermont (Fifth Bituminous,) coal basin.

The anticlinal (page 37,) at Smethport, is broken in its course as shown on the Geological Map of the county, (Plate X.) This change in the direction of its course has been produced by a greater elevation of the strata in the vicinity of Smethport, forming what I have named the *Smethport dome*, with quaquaversal dips. As nearly as could be determined, the centre of the dome lies about 1 mile to the west of Prospect Hill.

The strata here are found at a greater height than any where in the county. On the summit of the hill is found but a few feet of the lower part of the Olean conglomerate.

§ 342. The elevation of the bottom of the Olean conglomerate, has not been determined in a sufficient number of places to afford a means for the estimation of the dip of the coal measures.

The average rate of dip per mile of the Bradford oil sand from Smethport to other prominent points within the McKean oil district, is given in chapter XV, page 299.

§ 343. The vertical section which is known in Keating is longer than any other in the county. Its total length is nearly twenty-seven hundred (2700′) feet sub-divided into the following formations:

OUTCROPPING STRATA.

Shales and slate,		200′±
Clermont (Clarion) coal bed,		
POTTSVILLE CONGLOMERATE, No. XII.	Johnson run SS.,	
	Alton coals,	
	Kinzua creek SS.,	
	Marshburg (Upper) coal,	
	Olean Conglomerate,	
Mauch Chunk, No. XI and Pocono, No. X,		260′
Catskill, No. IX,		250′
Upper Chemung, No. VIII,		90′

STRATA IN OIL WELLS.

Upper Chemung, No. VIII,*	1212′
BRADFORD OIL SAND,	20′
Lower Chemung, No. VIII,	334′
SMETHPORT OIL SAND,	26′
Lower Chemung, No. VIII,	284′
Total,	2676′

§ 344. Only small and limited areas of the coal measures are found in Keating. The section extends from 5′ to 15′ of shales and slates overlying the Clermont coal bed downward some 200′ to the bottom of the OLEAN CONGLOMERATE. The thickness of the individual strata composing the coal measures is about the same as in Lafayette (page 189). No opportunity was afforded in this township of constructing a detail section.

§ 345. Some very small areas of the *Clermont coal* are to be found along the western township line. The coal has never been found here in workable condition. Ormsby's

*These measurements are taken from Smethport well, No. 1.

summit on the Smethport-Lafayette road some 5 miles west of the former place is underlaid immediately by the JOHNSON RUN SS. I did not see the Clermont coal bed here but it is reported to exist.

§ 346. The *Alton coal beds* have been opened in a number of localities but I do not know of their ever having been found of workable size or purity.

All the high summits west of Potato creek are capped by one of the sandstone members of the POTTSVILLE CONGLOMERATE.

§ 347. No exposure was found at the bottom of the Olean Conglomerate in the horizon of the Mauch Chunk shale, No. XI.

§ 348. The Pocono rocks vary in thickness from 260′ at Smethport to 285′* at Barrett's corners in the Marvin creek valley directly northwest of Chappel Hill.

At the latter locality I constructed the following section which shows the general character of the formation (page 167).

Pocono, No. X at Barrett's corners.

Concealed, (No. XI AND UPPER POCONO, No. X,)	60′
Partly concealed. Coarse grained ferruginous sandstone, (SUB-OLEAN CONGLOMERATE, MIDDLE POCONO, No. X,) . . .	40′
LOWER POCONO, No. X.	
Flaggy ferruginous sandstone containing fossils of Chemung type, ...	10′
Concealed, ...	50′
Gray shale with bands of ferruginous limestone, fossiliferous, (spirifer disjuncta, &c.)	40′
Green and brownish gray flaggy and shaly sandstone, ...	20′
Hard, silicious, gray limestone, containing fossil fragments, *Marvin creek limestone*, (page 68), ...	5′
Olive and gray shales and shaly SS., ...	60′
Total, ...	285′

§ 349. The red Catskill, No. IX has a thickness of 250′. The series is not exposed anywhere, so that a detailed section could not be constructed.

*This difference of 25 feet may not represent an actual difference in thickness but an error in the estimates.

§ 350. The Chemung rocks have been pierced in the Smethport, No. 1 and Haskill wells and their character is shown in the accompanying well records.

Smethport Well, No. 1.

§ 351. This well is located on the L. Taylor farm on the first north branch of Blacksmith run to the west of Smethport. The well was drilled by Lytle and Vezie in 1875 for the Smethport Oil Company. Specimens of all the drillings were kept but were lost before I had an opportunity to examine them. The record is considered to be reliable as far as it goes. It lacks in the detail of its statements.

	Well mouth above ocean in feet,			1590
1.	Red soil, (conductor,)	8 to	8=	1582
2.	Red sandstone,	2 to	10=	1580
3.	Red and gray sand,	10 to	20=	1570
4 & 5.	Sand very hard,	18 to	38=	1552
	UPPER CHEMUNG, NO. VIII.			
6.	Black slate,	22 to	60=	1530
7.	Slate,	10 to	70=	1520
8	Dark and very hard,	34 to	104=	1486
9.	Dark slate,	16 to	120=	1470
10.	Dark sand,	50 to	170=	1420
11.	Slate,	10 to	180=	1410
12.	Light slate,	20 to	200=	1390
13.	Slate,	10 to	210=	1380
14.	Light gray sand,	14 to	224=	1366
15.	Slate,	6 to	230=	1360
16.	Slate and shell,	100 to	330=	1260
17.	Shells very hard,	48 to	378=	1212
18.	Dark gray sand,	12 to	390=	1200
19.	White pebbles,	10 to	400=	1190
20.	Slate,	20 to	420=	1170
21.	Slate,	20 to	440=	1150
22.	Very muddy,	20 to	460=	1130
23.	Sand shells,	110 to	570=	1020
24.	Slate,	10 to	580=	1010
25.	Slate and sand shells,	547 to	1127=	463
26.	Coarse gray sand,	13 to	1140=	450
27.	Pebbles,	10 to	1150=	440
28.	Slate,	20 to	1170=	420
29.	Coarse sand,	10 to	1180=	410
30.	Hard fine white sand,	13 to	1193=	397.
31.	Slate,	17 to	1210=	380
32.	Dark gray slate,	10 to	1220=	370
33.	Slate and shell,	120 to	1340=	250

BRADFORD OIL SAND.

34 & 35.	White sand,	20 to 1360=	230

LOWER CHEMUNG, NO. VIII.

36.	Slate,	148 to 1508=	82
37.	Blue shell,	22 to 1530=	60
38.	Gray slate,	40 to 1570=+	20
39.	Slate and shells,	124 to 1694=—	104
40.	Dark brown sand (SMETHPORT OIL SAND),	26 to 1720=—	130
41.	Light gray slate,	60 to 1780=—	190
42.	Slate and shell,	120 to 1900=—	310
43.	Slate and shell,	104 to 2004=—	414

Drilled dry. Cased at 237′. At 1127′ in stratum number 26 a considerable showing of oil was obtained.

At about 1400 and 1500 feet a considerable quantity of gas was obtain about half as much as was obtained in the Haskill. There was not a sufficient quantity to run the boiler.

After the well was abandoned as a dry hole the casing was withdrawn and the surface water allowed to flow in.

In view of the fact that this well might sometime be further tested as to the probability of its producing petroleum, an attempt was made to plug the hole below all the water courses in order to prevent the water from flowing down and into the sand. A pine plug 5 feet long was driven into the well tightly, just below where the casing had ended. A large number of stones were dropped on top of the plug to offer a greater resistance to the pressure of the confined gas. This was done during the day, and on the following night both plug and stones were blown out of the hole by the gas.

The rocks of this well have been grouped under the following formations:

CATSKILL No. IX, (1 to 5 incl.)	38
UPPER CHEMUNG No. VIII, (6 to 33 incl.)	1302
Bradford oil sand No. VIII, (34 and 35,)	20
LOWER CHEMUNG No. VIII, (36 to 39 incl.,) shales, &c.,	334
Smethport oil sand, (No. 40,)	26
Shales, &c.,	284
Total,	2004

The SMETHPORT OIL SAND has been found in a number of wells to the east and in the vicinity of Smethport.

This oil horizon is the *lowest* geological horizon at which petroleum has been found in Pennsylvania.*

§ 352. *Haskill Well.*

This well is located on the east side of Marvin creek, about 1½ miles southwest of Smethport. Drilling was commenced December 1, 1876, and in the following April it was completed to a depth of 1581 feet. An arrangement was afterwards made with the drillers by which if they should continue drilling to a depth of 1700 feet they would be entitled to all the oil which was found. The total depth finally reached was 1861 feet.

The record was reported by Mr. William Haskill, formerly hotel proprietor in Smethport, a great many specimens were preserved of the drillings, and I believe the record is reliable as far as it goes.

Well mouth above ocean, in feet,		1552
1. Conductor,	30 to 30=	1522
2. Flagstone,	25 to 55=	1497
3. Blue slate,	165 to 220=	1332
4. Hard sand shells,	25 to 245=	1307
5. Blue slate,	175 to 420=	1182
6. Red shales,	25 to 445=	1107
7. Blue slate,	22 to 467=	1085
8. Red shale,	12 to 479=	1073
9. Hard shells and blue slate,	21 to 500=	1052
10. Hard blue rock,	2 to 502=	1050
11. Soapstone and shells,	103 to 605=	947
12. Very hard blue shales,	10 to 615=	937
13. Soapstone and hard shells,	45 to 660=	892
14. Sand open and porous,	20 to 680=	872
15. Soapstone and hard shells,	36 to 716=	836
16. Pebble sand and gas,	3 to 719=	833
17. Soapstone and shells,	61 to 780=	772
18. Hard gray sand,	5 to 785=	767
19. Soapstone and shells,	100 to 885=	667
20. Soft white slate,	35 to 920=	632
21. Slate and shells,	40 to 960=	592
22. Very hard shell,	5 to 965=	587
23. Very soft soapstone,	7 to 972=	580
24. Very hard sand shells,	3 to 975=	577
25. Slate and shell,	55 to 1030=	522
26. Stray sand,	15 to 1045=	507
27. Slate and shell,	40 to 1085=	467

* See page 291.

28.	Hard sand shell,	4 to 1089=	463
29.	Good stray sand,	4 to 1093=	459
30.	Slate and shell,	77 to 1170=	382
31.	Second sand,	45 to 1215=	337
32.	Slate and shell,	30 to 1245=	307
33.	Stray sand,	18 to 1263=	289
34.	Soapstone and shell,	82 to 1345=	207
35.	Sand, (show of oil, BRADFORD OIL SAND,)	12 to 1357=	195
36.	Soapstone shells,	93 to 1450=	102
37.	Shelly sand,	7 to 1457=	95
38.	Soapstone and shells,	23 to 1480=	72
39.	Shell strong gas,	2 to 1482=	70
40,41&42.	Soapstone shells,	138 to 1620= —	68
43.	Sand, (good show of oil,)	30 to 1650= —	98
44.	Hard shells and sandy slate,	63 to 1713= —	161
45.	Soapstone,	5 to 1718= —	166
46.	Oil sand,	18 to 1736= —	184
47.	Shells and sandy slate, (SMETHPORT OIL SAND,)	125 to 1861= —	309

Drilled dry. Cased at 250′. Gas at 719. Strong gas at 1482′ and 1620′. Smell of oil at 1263′. Show of oil at 1357′, 1482′ and 1620′.

It has been variously reported that the oil found in this well in small quantities came from the Bradford sand (stratum 35) and the Smethport sand (stratum 46.) At different times positive assertions have been made in regard to each horizon; from the latest reports it seems now quite certain that the bulk of the petroleum comes from the lower sand.

§ 353. A number of facts were obtained by Mr. Sheafer, in the latter part of April, 1880, in regard to the Smethport development. They all go to verify my interpretation of the structure, and give some additional points in relation to the dip of the BRADFORD OIL SAND. The more reliable information obtained, is published here as a matter of record.

§ 354. Brant & Co.'s well, No. 2,* located 30 rods (495′,) south of Haskill well.

Elevation top of well,	1606′
Depth to Bradford sand,	1360′
Depth to Smethport sand,	1754′
Thickness Smethport sand,	24′
Gas found at,	1630′
Torpedoed at,	1778′
Total depth,	1805′

* the Haskill well is sometimes called the Brant well, No 1.

This well in June, some 6 or 7 months after it was drilled, was producing about 1 barrel of oil a day; reported to come from the Smethport sand.

The elevation of the Bradford sand in this well is 246′, so that there is a north dip between this well and the Haskill, of 39′ in 495′.

§ 355. Brant & Co.'s well, No. 3, located 80 rods (1320′,) east, and 10 rods (165′,) south of No. 2.

Elevation of top of well,	1775′
Band of limy fossil shells, (8′ to 10′,)	1450′
Depth to top of Bradford sand, (20′,)	1510′
Total depth, (?)	1900′+

The top of the Bradford sand in this well is 58′ higher than in the Haskill well, and 19′ higher than in the Brant well, No. 2.

§ 356. Brant & Co.'s well, Wilcox tract. This well is located on Marvin creek.

Elevation of top of well,	1517′
Depth to Bradford sand, (35′,)	1293′

It was reported that a slight show of oil was obtained in the Smethport sand. Its position is not known.

§ 357. Hamar & Ernhout well, Fletcher tract, located in Marvin Creek valley, at the mouth of Head brook, Sergeant township.*

Elevation of top of well,	1715′
Depth to top of Smethport sand, (25′,)	1975′
Chocolate sand, (30′, contains an oil show,)	2200′
Total depth,	2230′

The Bradford oil sand was said to have been 25′ thick, but its position in the well was not reported. This well was completed March, 1879.

§ 358. Hamar's well, located on Wildcat run, Sergeant township.

Elevation of top of well,	1671′
Total depth,	2000′
Depth to top of Bradford sand, (20,′)	
Depth to top of Smethport sand, (12′,)	

There was a show of oil reported to have been found in both sands.

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* This record is placed here rather than in chapter X, on account of its relation to the Brant wells in the vicinity of Smethport.

§ 359. Lucius Rogers' well, located on warrant 2058, near Smethport, between county road and railroad.

Elevation of top of well, ...	1531′
Depth to top of Bradford sand, (30′ to 35′,)	1300′
Strong gas found in sand.	
Depth to top of Smethport sand, (contains an oil show,) . .	1723′

§ 360. Sherman, Hatch & Co.'s well. Located on Casper Smith's farm, warrant 2091, a short distance from school-house No. 6, at Farmers' Valley, Keating township.

Depth to top of Smethport sand (20′), ...	1780′
Drilling stopped at	1811′

§ 361. None of the wells in the vicinity of Smethport have as yet paid. From the irregular dips* and consequently more or less fractured condition of the strata, resulting from the occurrence of the *Smethport dome*, it is *quite improbable* that a good productive oil territory will ever be found in this part of the county.

§ 362. *Running Section from Smethport to Summit township, W. 2060.*

Bar. elevation.	Description.	Locality.
1493′	. . . .	Smethport station, (McK. and B. RR.)
1530	. . . .	School-house at junction of roads.
1533	. . . .	Junction of roads.
1902	Red and gray micaceous shales, 3′.	
1907	Red and gray micaceous shales, more massive, 1′.	
1917	Red shales, 3′	
1975	Red shales.	
2107	Red shales, 3′.	
2130	Gray shaly soil.	
2375	. . . .	Summit of road.

* The relation of the dip of the oil sand to its productiveness will be treated of in the special report on the oil districts.

§ 363. *Running Section from Smethport to Port Allegheny.*

Bar. elevation.	Description.	Locality.
1493′	. . . .	Smethport station, (McK. and B. RR.)
1530	. . . .	Junction of roads at school-house.
1648	Red shale soil, ...	Junction of roads.
1785	Red shale soil.	
1890	Gray shales, loose.	
1975	Red shale soil.	
1990	Red shale, 1′.	
2033	Red shale.	
2054	Red shale.	
2086	Red shale, 2′.	
2096	Red shale, more massive, 1′.	
2106	Red shale.	
2140	Red shale.	
2145	Red shale, ...	Summit of road.
2140	. . . .	Junction of roads.
2065	Red shale.	
2096	10′ red shales, ...	Camel's house.
2225	Olive and red shales, 3′.	
2500±	. . . .	Summit south of Camel's house.
2065	. . . .	"Devil's Elbow."
2025	Red shale.	
2020	Gray shale soil, ...	Junction with road down Open brook.
2415	Gray flaggy SS., ...	Top of hill S. of Open Brook road.
1862	Gray shales.	
1730	Green shales.	
1725	Red soil.	
1665	. . . .	Brook crossing.
1610	. . . .	Junction of roads.
1710	Red soil.	
1795	. . . .	Summit.
1513	Junction, ...	Junction of roads.
1545	Olive shales, 2′.	
1482	. . . .	Port Allegheny station, (B., N. Y. & P. RR.)

9. *Liberty Township.*

§ 364. This township lies to the south of Annin, east of Keating and Norwich, and joins Pleasant valley, Roulet and Keating townships, Potter county, on the east. With the exception of a very small area in the southern part, the township lies in the Allegheny river Sub-basin (page 4.) It is drained by the Allegheny river and Allegheny Portage creek and their branches.

The greatest height in the township is in the vicinity of Prospect Hill, nearly on the line between Keating and Liberty. The lowest point is where the river crosses its northern boundary line at an elevation of about *1445′*.

§ 365. It lies in the *Fourth and Fifth coal basins*, and is traversed in a northeast and southwest direction by the

Axis of the Norwich (Fourth) Basin,
Norwich anticlinal,
Axis of the Clermont (Fifth) Basin and the
Smethport anticlinal.

§ 366. The dip of the rocks in this township is possibly greater than anywhere in the county. The southeast dip from Prospect Hill to the center of the Skinner creek coal patch is at the average rate of 185′ per mile. The base of the OLEAN CONGLOMERATE at the former place is *2480′*, while at the latter locality it is only *1950′*. Beside southeast and northwest dips from the anticlinals toward the center of the basins there is a general falling away of the strata toward the southwest.

§ 367. The total thickness of rocks exposed above water level in the township is about *890′*, sub-grouped as follows:

COAL MEASURES, (including conglomerate No. XII,)	190′
MAUCH CHUNK No. XI, / POCONO No. X, ...	250′ to 300′
RED CATSKILL No. IX, ...	300′
CHEMUNG No. VIII, ...	100′±
Total, ...	890′

§ 368. The highest stratum is the KINZUA CREEK SANDSTONE in the center of the Skinner creek coal patch. The top of the ridge formed by it is *2140′* high.

§ 369. Two coal beds were opened here by Mr. Seth A. Backus about 1855. Each bed was from 18 to 20 inches thick and 30′ apart. The upper bed occurs 40′ below the top of the ridge. The lower bed was of a very good quality, and was separated by a thin parting of slate from an overlying iron ore bed 9 to 12 inches thick. The ore is said to have averaged on analysis 56 per cent. of metallic iron.*

* This is no doubt an exaggerated report.

These coals were merely opened at test drifts. A small quantity was mined and sent to Smethport and Port Allegheny for blacksmith's use. The beds without doubt belong to the *Alton group.*

§ 370. One of these beds was opened by Mr. S. H. Barrett of Port Allegheny, a short distance from the Backus openings. After digging through 6′ of dirt a seam of coal 2′ 4″ in thickness was found. The lower portion of the bed was light in weight, the upper part being composed of a fine, black, glossy coal. There was no parting in the seam. About 10 tons were mined at the opening and taken to Port Allegheny for blacksmithing.

The details of the section of the coal measures do not differ from those in Norwich (page 99) and Sergeant (page 127) townships.

§ 371. The sub-conglomerate (No. XII) measures are exposed in a number of localities, but the exposures are not sufficiently continuous to permit of the construction of sections of any great length. The estimated thickness of No. X and No. IX along Lillibridge creek is 300′ respectively.

The top of the Chemung at Port Allegheny lies about 50′ under the level of the river.

§ 372. The following running sections are published as a matter of record. The dips are too great and too indeterminate to permit of the observations being placed in the form of a vertical column:

§ 373. *Running Section from Port Allegheny to Comes creek summit.*

Bar. elevation.	Description.	Locality.
1482	. . . .	Port Allegheny station, (B., N. Y. & P. RR.)
1480	. . . .	Bridge over the Allegheny.
1490	. . . .	Bridge over Portage.
1500	Green flaggy SS., with red shale 10′, ...	Quarry west end of bridge.

1525	Red soil.	
1555	Red soil.	
1585	Red soil.	
1585	. . . .	Stream near Eastwoods.
1615	Red soil.	
1655	Green shales.	
1655	Red soil, ...	School-house.
1665	. . . .	Stream.
1670	Red shales.	
1750	Red soil.	
1765	. . . .	Bridge over creek.
2255	SS. gray and yellow coarse grained, with small round pebbles, ...	Summit of road.

§ 374. *Running Section from Port Allegheny to head of Lillibridge creek.*

Bar. elevation.	Description.	Locality.
1482	. . . .	Port Allegheny station, (B., N. Y. & P. RR.)
1493	. . . .	Bridge over creek.
1545	Soil slightly red, ...	Crossing brook from the east.
1582	Soil red.	
1612	Soil red, ...	Brook crossing.
1705	. . . .	School-house.
1725	. . . .	Road to saw-mill.
1775	. . . .	Brook crossing.
1920	Red shale.	
2080	Red shale.	
2260	Gray flaggy SS., ...	Summit.

§ 375. *Running Section from Two Mile run summit to Port Allegheny.*

Bar. elevation.	Description.	Locality.
2375	. . . .	Summit.
2290	Red shale.	
2060	Red soil.	

1970	Red soil.	
1980	Gray flaggy SS., red on surface.	
1915	Red soil.	
1825	. . . .	Uptegroves.
1830	. . . .	Junction with road to Annin.
2020	Red soil.	
2300	Gray flaggy SS., ...	Summit between roads.
1955	Red soil.	
1705	Red soil.	
1635	. . . .	Bridge over.
1450	. . . .	Bridge over Two Mile run near its mouth.
1482	. . . .	Port-Allegheny station, (B., N. Y. & P. RR.

CHAPTER XV.

*The Bradford Oil District.**

§ 376. The development and growth of the Bradford district has been quite different from that of the other oil districts of Pennsylvania. The completion of a ten barrel well in November, 1871, claimed no attention from the oil producer. Those who *happened* to hear of the Moses well, (page 80,) not only considered it an anomoly, but a foolish venture on the part of the Foster Oil Company. They maintained that the oil was found at too great a distance from any proven territory; came from too great a depth, (over 1100 feet,) and occurred in too fine a sand to amount to anything.

In the three following years, Messrs. Butts and Foster, who were interested in the Moses well, made repeated efforts to drill other wells, but were discouraged by even the most sanguine of the Venango producers from making any further test. Their second venture, completed three years from the time they "*struck oil*" in the Moses well, produced them 70 barrels of oil per day. This fact, together with the undiminished production of the Moses well, proved to the producer that there was some petroleum in McKean county, whose development might be profitable. The unparalled growth of this field is evidenced by the fact, that in December, 1879, five years from the completion of the Butts well, No. 1, the average daily production of the en-

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*** Upon assuming the charge of the survey of McKean county, my instructions were to examine and report on the general geology, and the extent and value of the COAL MEASURES, leaving the examination of the OIL DISTRICT for a special survey, which should be made in the future.**

All the facts which I have obtained bearing upon petroleum are of a general character, and were gotten in prosecuting my special work. I made no special effort to procure any details in regard to the oil developments, as my jurisdiction did not embrace a study of the oil districts.

tire district was 45,000 barrels, or about 79 per cent. of the daily production of the whole State of Pennsylvania.

§ 377. The following table gives the rapidity of growth:

Daily production of the Bradford district compared with the total daily production of the State:

		State.	*Bradford.*	*Proportion.*
1874,	December,	27,682 barrels.	75± barrels.	
1875,	June,	23,207 "	125± "	
	December,	23,254 "	149 "	
1876,	June,	24,120 "	800 "	3%
	December,	25,390 "	1,800 "	7%
1877,	June,	37,693 "	3,449 "	9%
	December,	40,518 "	8,000 "	19%
1878,	June,	40,575 "	16,000 "	39%
	December,	42,538 "	23,700 "	56%
1879,	June,	55,105 "	38,000 "	69%
	December,	57,076 "	45,000 "	79%
1880,	June,	67,201 "	58,000 "	86%

If these figures should be compared with those showing the daily production semi-annually in any of the individual oil districts of the State it will be found that the growth and development of Bradford has been the most rapid of any.

To account for these results there naturally must be some structural difference in the Bradford sand and mode of occurrence of the oil.*

§ 378. Some general facts showing the relative percentage of *dry holes* and the out-put of the *producing wells* in the Bradford district and the entire State exclusive of this district will enable the reader to better appreciate the differences in the sands already enumerated.*

During the year 1879, there were 475 wells drilled to the Venango oil sands in the counties of Warren, Venango, Clarion and Butler; of this number 122 were *dry holes* or produced no oil; being 25.7 per cent.

In the Bradford or Northern district, there were during the same year, 2536 wells drilled to the Bradford oil sand, of which number but 76 were *dry holes* or only 3 per cent.; being nearly 23 per cent. less than in the Venango or Western district.

*Page 75.

The average daily production, for the first month, of the wells drilled in the Bradford sand was about 20 barrels, while for the wells in the Venango sands it did not attain that amount.* When we take these facts into consideration, we can readily understand why there should have been 2536 wells drilled in the northern district to only 475 in the western.

Since the beginning of the year 1875, when the Bradford oil horizon was discovered, up to January, 1880, there have been 6249 wells drilled in the district, of which 236 were dry holes or 3.77 per cent. From the most authentic statistics which I can gather in the western district, about one fourth of all the wells which have been drilled in the Venango sands, since their discovery in 1859, have proved dry.

Geological position of the Oil Sand.

§ 379. In the general description of the Sub-conglomerate Measures, Chapter VII, the Bradford oil sand is referred to the Lower Chemung rocks; some of the general facts which have led to this conclusion are given below.

The early drillers in the territory regarded the oil as coming from the same geological horizon as that occupied by the "Third Sand" along Oil creek, in Venango county. Inconsistent as this idea was with known facts in the geology of northwestern Pennsylvania, the *producing sand* was named the "Third Sand," and the determination of a "First" and "Second" sand was left to the driller. No careful examination was made of the "sand pumpings," but from the way the drill pierced the strata two sand horizons were located. The upper sand, about 600 feet above the producing sand, was named the "First Sand;" the lower one, 300 feet above the same horizon, was named the "Second Sand."

§ 380. The opinion which had been frequently expressed

*Some of the wells drilled to the Venango third oil sand have produced from 2000 to 3000 barrels of oil per day, while the largest well ever found in the Bradford district has not exceeded as many hundred. The largest individual wells have been located in the western district; the largest average wells in the northern district.

by expert geologists that there was little probability of finding the Oil creek sands north of the Philadelphia and Erie railroad was denied by the driller on the basis of what he regarded as overwhelming evidence. As far as nomenclature went the comparison between the Venango and McKean county oil rocks seemed perfect. Along the Allegheny river, in the former county, the drill had proven the existence of three distinct sand horizons producing petroleum, which had long been known as the "First," "Second," and "Third" sands, the latter being the most productive.

§ 381. One mile above Oil City, in Venango county, the top of the "Third Sand" is 528 feet above ocean level. At Bradford, which is 64 miles, north 55 degrees east, of Oil City, the top of the producing sand is only 414 feet above ocean level. If the producing sand in the two localities was the same, there would be a dip in the sand from Oil City to Bradford of (528–414) 114 feet. Between these two places the surface rocks have a persistent dip to the southwest, which averages about 14 feet per mile. This estimate is based on the identity of the Second Mountain Sand, the bottom of which north of Oil City is about 1290 feet above ocean level, with the Olean conglomerate, the bottom of which, at Bradford, is 2170 feet above the same datum.

The interval between the outcropping conglomerates and the geological horizon of the "Oil creek Third Sand" probably varies but little between the two points, so that the stratum, whatever it be, which occupies the horizon of the "Third Sand' in McKean county, should be found at Bradford at about water-level. But the top of the sand which produces the petroleum at Bradford is found 1030 feet below water-level.

In Venango county, according to Mr. Carll, (see his Reports I, III,) the average distance from the top of the "First sand" to the bottom of the "Third sand," is 315 feet. In McKean county, I find from a study of a number of well records, that the average distance from the top of the First sand, so called, to the bottom of the so-called "Third," or producing sand, is 660 feet. Here then are two facts which cannot be denied, if the "Oil creek Third

sand" is geologically the same as the Bradford sand: First, the Bradford sand is over a *thousand feet* lower than facts would lead us to suppose, and, second, the group of oil rocks in McKean county are over *three hundred feet* too thick. Again, if the Venango and McKean oil sands were the same, of course the whole rock series would have to thicken very much to the northeast.

§ 382. The accompanying chart of sections (plate VII) shows that the Pocono, No. X, Catskill, No. IX, and probably the Upper Chemung rocks, No. VIII, thicken very materially from Bradford south to Ridgway. If the strata from the Second mountain sand to the "Oil creek Third sand" did not remain approximately constant from Oil City to Bradford, as we have supposed, there would be many more reasons to assign a thickening to the southwest rather than to the northeast.

Mr. Carll, in the early part of 1876, published the fact that the Bradford *producing sand* was probably 1000 feet below the "Oil creek Third sand." Facts since obtained show this to have been a close estimate.*

§ 383. To make a comparison of the rocks passed through in the two districts, it was necessary to have complete and authenticated records. No accurate register of the rocks has ever been kept by any of the producers in the Bradford district. This fact can readily be accounted for when it is remembered, that with the exception of the wells at State Line and Limestone, N. Y., the bulk of the production comes from one horizon. The difference in the strata is so slight, that except by a close examination of the sand pumpings, it is impossible to distinguish any change in the succession of the sedimentary deposits.

§ 384. In December, 1877, Professor Lesley appointed Mr. Author Hale to the special work of obtaining a correct record of the Dennis & Co.'s well, No. 1, which was about to be drilled on the high summit about three quarters of a mile southwest of Bradford. This well was completed in the early part of 1878. The measurements were made with great care, and wherever the rock was found to change a

* Report III, pages 160 and 161.

specimen or specimens were secured for future study. The depth of the well is 1719 feet. The elevation of the floor of the derrick above ocean is 2055 feet, Bradford station on the Erie railway (now N. Y., L. E. and W. railway) being 1444 feet. This record is without doubt the *longest detailed and accurately measured* record of any oil well in the United States. Deeper wells have been drilled, but no record has ever been kept so accurately as this one to such a depth. A complete description of the record is contained in a paper which I read before the American Philosophical Society, September, 1878.

The top of the well is stratigraphically 115 feet below the bottom of the Olean Conglomerate, which is the lowest member of Coal Measure conglomerate, No. XII, and which caps the highest summits in the vicinity of Bradford.

The Mauch Chunk shales, No. XI, if present in this part of the county, are represented by the shales immediately underlying the Olean Conglomerate. They cannot be more than 5 or 10 feet thick.

The total thickness of No. X, is about 240 feet, allowing 7 feet for the shale of the Mauch Chunk No. XI, immediately underneath the Olean.

The following is the record of the well in detail:*

C. W. Dennis & Co.'s Well, No. 1.

Owned by C. W. Dennis & Co., situated on the Roger's farm, three fourths of a mile south 35° west of Bradford, Bradford township, McKean county.

The elevation of the top of the well above ocean in feet, is 2055. The elevation of the Bradford station, on the Bradford branch of the N. Y., L. E. and W. R. R., being taken as 1444 feet.

Lower Pocono, No. X.

Elevation of top of well,		=2055
1. Surface clays,	4 to	4=2051
2. Sandy shale, olive gray, micaceous, muddy; spec. 1,	11 to	15=2040

*The record is placed here, rather than in the report on Bradford township, as it is the only detailed record in the Bradford District.

3. S.S. gray, fine, micaceous, muddy; specs. 2, 3, 4, 5, ...	33 to	48=2007
4. Shale dark gray, with thin micaceous sand shells, muddy; specs. 6, 7, ...	19 to	67=1988
5. S.S. gray, fine, soft, muddy; spec. 8, . . .	8 to	75=1980
6. Slaty sandstone, bluish, fine, muddy; specs. 9, 10, ...	23 to	98=1957
7. Fine gray sand-shells and dark slates alternating, muddy; specs. 11, 12, 13, ...	18 to	116=1939
8. S.S. ashy gray, very fine micaceous, muddy; specs. 14, 15, ...	16 to	132=1923

Red Catskill, No. IX.

9. Red shale, soft; spec. 16, ...	6 to	138=1917
10. S.S. olive gray, fine micaceous; spec. 17, . .	12 to	150=1905
11. S.S. dark olive gray, fine micaceous; specs. 18, 19, 20, ...	30 to	180=1875
12. S.S. white, mixed with green and brown, fine; spec. 21, ...	8 to	188=1867
13. S.S. bluish gray, fine, micaceous, muddy; spec. 22, ...	9 to	197=1858
14. Red shale, "paint rock," top soft, bottom sandy and micaceous; specs. 23, 24, 25, ...	18 to	215=1840
15. S.S. gray, fine, mixed with slate, a few pebbles; specs. 26, 27, ...	23 to	238=1817
16. Slate, bluish; specs. 28, 29, 30, 31, ...	22 to	260=1795
17. Slate, bluish, with thin plates of fine sandstone; specs. 32, 33, ...	15 to	275=1780
18. Sandy slate, dark gray, fine, micaceous; specs. 34, 35, 36, ...	16 to	291=1764
19. Slate, bluish; specs. 37, 38, 39, ...	24 to	315=1740
20. S.S. gray, fine, micaceous; spec. 40, ...	5 to	320=1735
21. Red slate, micaceous, muddy; specs. 41, 42, .	8 to	328=1727
22. S.S. olive gray, soft, micaceous, some slate; specs. 43, 44, 45, ...	39 to	367=1688
23. Red rock, mottled sandy shale, brown, green and gray; specs. 46, 47, ...	15 to	382=1673

Upper Chemung Shales and Sandstones, No. VIII.

24. Slate sandy, gray; spec. 48, ...	8 to	390=1665
25. S.S. dark, very fine; specs. 49, 50, ...	10 to	400=1655
26. S.S. gray, very fine, hard, drillings like flour; specs. 51–56 inclusive, ...	35 to	435=1620
27. Slate, sandy micaceous; specs. 57 to 63 inclusive, ...	38 to	473=1582
28. S.S. dark gray, very fine, micaceous, flaky; spec. 64, ...	6 to	479=1576
29. S.S. bluish gray, fine, hard, remnants of fossils; spec. 65, ...	6 to	485=1570
30. Slate, sandy in streaks, micaceous, fossil bands; specs. 66–76 inclusive, ...	95 to	580=1475

31. Dark gray, thin-bedded S.S., fine, micaceous, slate partings, fossils; specs. 77 to 89 inclusive, ... 71 to 651=1404
32. S.S. gray, fine, flaky, micaceous, fossils; specs. 90, 91, 92, ... 23 to 674=1381
33. Slate; specs. 93, 94, ... 12 to 686=1369
34. S.S. dark gray, slate partings, fossils; specs. 95, 96, 97, 98, ... 26 to 712=1343
35. Red rock, purplish, sandy, very fine, micaceous, fossils; specs. 99, 100, ... 10 to 722=1333
36. Sandy slate, dark, micaceous; specs. 101, 102, 103, ... 20 to 742=1313
37. S S. fine, micaceous, alternating with slate and "chocolate" shale, fossils; specs. 104 to 113 inclusive, ... 63 to 805=1250
38. S.S. thin bedded, micaceous, slate partings, fossils; specs. 114, 115, ... 13 to 818=1237
39. Slate, an occasional sand-shell with fossils; specs. 116 to 136 inclusive, ... 125 to 943=1112
40. S.S. brown and purplish, fine, hard, fossils; spec. 137, ... 8 to 951=1104
41. Slate, dark lead color, ... 55 to 1006=1049
42. "Red Rock," fine, purple and gray sandy slate; specs. 147, 148, ... 14 to 1020=1035
43. Gray sand, shells and slate, fossils; specs. 149 to 153 inclusive, ... 24 to 1044=1011
44. Slate; specs. 154, 155, ... 12 to 1056= 999
45. S.S. dark, hard, fine; spec. 156, ... 3 to 1059= 996
46. S.S. yellow gray, drillings as fine as flour; specs. 157 to 163 inclusive, ... 13 to 1072= 983
47. Slate; specs. 164, 165, ... 5 to 1077= 978
48. S.S. yellow gray, fine; spec. 166, ... 4 to 1081= 974
49. Slate, sandy; specs. 167, 168, 169, ... 7 to 1088= 967
50. S.S. dark gray, fine, fossils; specs. 170, 171, . 6 to 1094= 961
51. Slate; specs. 172 to 175 inclusive, ... 17 to 1111= 944
52. S.S. brown and gray, fine, soft with some slate, (oil show;) specs. 176 to 180 inclusive, . . 14 to 1125= 930
53. Slate; specs. 181 to 186 inclusive, ... 23 to 1148= 907
54. Slate, with dark sand shells; specs. 187 to 190 inclusive, ... 15 to 1163= 892
55. Slate; specs. 191, 192, ... 13 to 1176= 879
56. Slate, with gray sand shells; specs. 193, 194, . 5 to 1181= 874
57. Slate; specs. 195, 196, 197, ... 12 to 1193= 862
58. Slate, with an occasional sand shell; specs. 198 to 206 inclusive, ... 44 to 1237= 818
59. Slate, "blue slate;" specs. 207 to 219 inclusive, 63 to 1300= 755
60. S.S. brown, fine, flaky, slate partings, fossils; specs. 220 to 223 inclusive, ... 17 to 1317= 738
61. Slate; specs. 224 to 229 inclusive, ... 28 to 1345= 710
62. S.S. dark gray, fine, close, hard; specs. 230, 231, ... 6 to 1351= 704

63. S.S. brownish gray, fine, slate partings; specs. 232 to 237 inclusive,	30 to 1381= 674
64. Sand, shells and slate; specs. 238 to 242 inclusive,	22 to 1403= 652
65. Slate, sand shell at 1428'; specs. 243 to 254 inclusive,	59 to 1462= 593
66. Fine sand shells, and slate alternating; specs. 225 to 261 inclusive,	25 to 1487= 568
67. Slate and shells at 1510', 1531', and 1573'; specs. 262 to 286 inclusive,	118 to 1605= 450
68. Slate, with sand shells; specs. 287 to 291 inclusive,	27 to 1632= 423
69. Slate; specs. 292 to 295 inclusive,	32 to 1664= 391

Bradford Oil Sand.

70. S.S. brown, fine, flaky. Bradford "3d," or oil producing sand; specs. 296 to 310 inclusive,	54 to 1718= 337
71. Slate and S.S.; spec. 311,	1 to 1719= 336

The rocks pierced by the drill in the Dennis well, may be summed up as follows:

Drift and Lower Pocono, No. X, (1 to 8 incl.,)	132'
Red Catskill, No. IX, (9 to 23 incl.,)	250'
Upper Chemung, No. VIII, (24 to 69 incl.,)	1282'
Bradford Oil Sand, No. VIII, (70,)	54'
	1'
Total,	1719'

The top of the ridge directly above the Dennis well, No. 1, is capped by the Sub-Olean Conglomerate, which lies from 50 to 70 feet below the bottom of the Olean Conglomerate; the top of the well is about 115 feet below this latter horizon.

The sandstone and conglomerate which caps the summits surrounding Bradford, and which is found broken up in large masses on the hill slopes, comes from the Olean Conglomerate.

Three hundred and twelve specimens were obtained of the strata encountered in the Dennis well.

§ 385. For convenience of study I have placed a portion of each specimen in a homeopathic vial, half-inch diameter. These vials are placed on their sides, and piled one upon another, and placed in three walnut cabinets, each cabinet containing 104 bottles. Each bottle is separated by a small strip of tin from the adjoining bottle, so that any one may

be removed for examination without disturbing the others. The space in each cabinet which contains the samples is 5¾ feet long and 2½ inches wide.

To the right of the rock column I have placed a columnar section drawn to scale, so that the specimens may be referred directly to their vertical position in the well record. It will be noticed that the bottles themselves are not placed according to scale, but are piled directly one upon another, irrespective of the interval which separates them in the record. If the specimens had been placed to scale the total length of the section would have been 45 feet instead of 17½ feet as at present. The size of the cabinets would have been awkward, and no material advantage would have been gained. I have given the above description, from the fact that I believe it to be the best method for the study of well records in connection with specimens of the borings.

§ 386. In the Haskill well at Smethport, fifteen miles southeast of Bradford, a sand was struck at 1345 feet, and was reported to be 12 feet thick. The sand which at present is producing about two barrels of oil a day in the Haskill well was found at a depth of 1718 feet, and is 18 feet thick. Drilling was continued to 124 feet below the lower or producing sand. The Smethport producing sand, by most of the producers, is considered to be the same as the Bradford sand. From a careful study which I have made of a number of surface sections and well records in northern McKean county, I have come to the conclusion that the upper sand in the Haskill well is the representative of the Bradford sand, and that the lower or producing sand in this well lies 360 feet geologically lower than the great productive horizon of the Bradford district.

The Smethport oil horizon is interesting, from the fact that it is the *lowest* geological horizon at which petroleum has been found in Pennsylvania. I announced the discovery of this fact in a paper, which I read before the Engineers' Club of Philadelphia, February 16th, 1878, on the "Oil Sands of Pennsylvania." At that time, the sand had not been found at Smethport, but had been pierced by the drill in a well at Sartwell, in an adjoining township.

§ 387. I have named the rocks in the Dennis well after a careful study of the same series throughout McKean and Elk counties, embracing a territory 45 miles to the south of Bradford, west into Warren county, and east and south-east into Potter and Cameron counties. A careful examination of the fossil forms in this district from the Chemung up into the Lower Productive Coal Measures has been made, but the means which the fossils afford for stratigraphical determinations are extremely limited.

§ 388. Palæontologically considered, the rocks from the base of the Olean Conglomerate, No. XII, to the bottom of the deepest valley, some 800 feet in all, are essentially one group incapable of sub-division. They contain in all eighteen Waverly species, seven Chemung species, and one of Carboniferous type. I have grouped the rock series mainly from lithological determinations, which undoubtedly lead to the most reliable and accurate conclusions, when sufficient sections can be had for a comparison. Having determined the relation of the *producing sand* at Bradford to the overlying strata, I next sought for some constant horizon which should afford the best means of comparing distant sections. This was of importance in order to ascertain the approximate depth below the surface of the Bradford sand in any territory adjacent to the developed district, in which petroleum should be drilled for. The rock most constant in its general character in McKean and Elk counties, seems to be the Olean Conglomerate.

Between this conglomerate and the oil-bearing sand there is no stratum or series of strata, with possibly the exception of the red shale bands of the Catskill, No. IX, and Chemung, No. VIII, which can furnish a reliable guide to the oil prospector.

§ 389. The sandy measures in the 1000 or 1500 feet immediately overlying the oil sand at Bradford are poor guides in looking for the oil sand in new or wild-cat territory. They lead to confusion, error, and disappointment. There is no guide which the driller considers more infallible than the so-called "First" and "Second" sands. It is true that in a limited territory, there are distinct sand strata 300 and

600 feet respectively above the Bradford sand, but I believe it impossible to determine the position of the oil sand by an arbitrary location of these upper sands.

§ 390. One important fact, which is too often overlooked, is that the rocks may thicken or thin between two constant horizons in comparatively short distances, so that allowances must be made, either plus or minus, in estimating the proper depth to drill, in order to strike the *producing sand*.

The accompanying sections (plates VII and XI) show the position of the Bradford *producing sand* below the Olean Conglomerate at Bradford, in the Haskill well at Smethport, in the Wilcox wells, in the Bear Creek well, in the Silver Creek well, and in the old Dickinson or Ridgway well. The horizon of the sand in the three latter wells is probably about the same depth below the bottom of the Red Catskill, as it is in the Wilcox wells. Although the bottom of the Olean Conglomerate in the vicinity of these different wells is found at various elevations, yet I have placed it in the drawing on the same horizontal line, for convenience of comparing the underlying strata.

It will be noticed that the Pocono formation, No. X, and Red Catskill, No. IX, thicken very much south from Bradford. As a consequence, the Bradford oil sand horizon at Ridgway, would be found nearly 600 feet further below the Olean rock than it is at Bradford. This fact has a very important practical bearing. The Bear Creek well, which was drilled to a depth of 1998 feet, and the Silver Creek well, which is 1760 feet deep, have both been abandoned long before the Bradford sand could possibly be reached. I do not mean to say that if these wells were drilled to the proper depth, they would produce petroleum, not at all, but I do assert that they should be much deeper to strike the Bradford sand if it underlies this portion of Elk county.

These two wells form examples of many that I could cite, where the money spent in drilling has been more than thrown away. They prove nothing, and only tend to condemn the territory as "dry," without any facts to support

such a conclusion. Can it be denied that geological work is of practical use to the oil prospector?

It will be noticed that between Bradford and Smethport, the strata from the Olean rock to the Bradford sand, maintain almost a constant thickness. From Bradford, southwest to the Hukill well, which is one and a half miles northeast of Ludlow station, the Pocono, No. X, thickens about 100 feet, while the other formations remain about the same as in the Dennis well. In the Wilcox wells, No. X, is about the same thickness as in the Hukill well. The greatest amount of change in the two counties, takes place between the Wilcox wells and the Bear Creek well. In this distance of 8½ miles, the interval from the bottom of the Olean to the top of the Catskill, thickens to the south at the rate of 28½ feet per mile. The same rocks between the Bear Creek and Ridgway* well, thicken to the south at the rate of 14 feet per mile. From the Wilcox wells to the Ridgway well the Red Catskill, No. IX, thickens at the average rate of 4½ feet per mile.

If it were not for the geological fact that the formations thicken in Elk county rapidly to the south, the Bear Creek well would be deep enough to have encountered the horizon of the Bradford sand.

The elevation of the bottom of the Olean Conglomerate in the vicinity of the Wilcox wells is 1900 feet; at Ridgway, the same geological horizon is 1690 feet above tide, so that the *average dip* of the bottom of No. XII between the two places, is about 13½ feet per mile. The southern dip of all the rocks below the Olean, would be greater than 13½ feet per mile on account of their thickening to the south.

*A thickness of 675′ is assigned to the Pocono No. X in the Ridgway section plates VII and XI. It should be only 625′ as stratum No. 2 is 70′ thick instead of 120′. This error was made in originally locating the bottom of the Olean Conglomerate too high in the Ridgway Hill. The error was detected and corrected after the Marshburg lower coal bed had been opened by Mr. Gresh to the north of the Ridgway RR. station. Some of the local authorities think that the Olean Conglomerate lies still below this coal bed. I have placed it above the coal.

	Distance in miles from Dennis well	Direction from Dennis well.	THICKNESS OR FORMATION, IN FEET.				Elevation of top of well.	Depth to top of Bradford oil-sand.	Elevation of top of Bradford oil-sand.	Total depth of well.
			No. XI.	No. X.	No. IX.	No. VIII, to top of Bradford oil-sand.				
McKEAN COUNTY.										
Dennis well, Bradford,	....	....	No. XI, in McKean co., has not been absolutely recognized, but is probably represented by 5 to 10 feet of shales under the Olean Conglomerate.	250	247	1282	2055	1664	391	1719
Hulings well, Kinzua Creek,	13.39	S. 8° 30′ E.		.....	.....	....	1625	1545	80	1650 (?)
Sand at Lewis Run,	....	....		.....	.....	....	....	.. ..	294	
Smethport well,	13.77	S. 49° 00′ E.		280	.....	....	1590	....	250	2004
Haskill well, Smethport,	14.92	S. 44° 30′ E.		260	250	1305	1552	1345	207	1861
Hukill well, N. E. of Wetmore,	18.72	S. 41° 30′ W.		343	280	1299	1846	1950 (?)	101	2011
Wilcox well, No. 3,	21.25	S. 4° 00′ W.	....	330	263	1305	1666	1685	19	1850
Coburn well,	21.65	S. 10° 45′ W.	....	325	260±	1318	1900	1944	44	2268
Ernhout and Taylor, No. 2,	22.80	S. 11° 00′ W.	....	340	.....	....	1730	1880	150	2000
ELK COUNTY.						No. VIII, to bottom of well.				
Bear Creek well,	29.37	S. 4° 30′ W.	45	520	318	1055	1595	Not reached.	....	1998
Silver Creek well,	29.92	S. 6° 00′ W.	45±	....	.....	797	1615	"	....	1760
Ridgway well,	36.8	S. 6° 40′ W.	45±	625	.....	70	1853	"	....	772

The distance drilled below the top of the Bradford sand may be found by subtracting the depth to the top of the sand from the total depth of the well.

Dip of the oil sand.

§ 391. A determination of the dip of the *Bradford oil producing* sand is of importance to the operator in order to ascertain the probable depth to which wells must be drilled to pass through the sand bed. This could be obtained directly from surface observations if the strata included between the oil sand and some well-defined outcropping rock should maintain a constancy of thickness. From an examination of a number of well records scattered over the county, it is found that the distance of the top of the sand below the bottom of the OLEAN CONGLOMERATE is variable as shown by the following table.

§ 392. Depth of the oil sand below the bottom of the Olean conglomerate:

Dennis well, Bradford twp.,	1779′
Lewis run, Lafayette twp.,	1780′
Haskill well, Keating twp.,	1805′
Hukill well, Hamilton twp.,	1902′
Coburn well, Wetmore twp.,	1898′
Wilcox wells, Sergeant twp.,	1890′±
Bear creek well, Elk county, (estimated,)	2150′±

This shows a progressive thickening of these formations between the Dennis and Bear creek wells, (distance 29.29 miles,) of about 375 feet. Most of this takes place between the south line of the county and the Bear creek well.

§393. The rate of thickening being known per mile, and the position of the bottom of the Olean conglomerate being determined in any one locality, the depth of the Bradford sand below the surface is readily ascertained.*

§ 394. From a number of well records which were obtained I have selected those grouped in the following table as the more reliable in order to show the elevation above mean Atlantic ocean level at which the top of the producing sand occurs. The figures here found show as nearly as could be desired the main structural features of the sand bed; the general dips can readily be computed and will locate the

* The dips of the anticlinals and synclinals are so slight that there is no perceptible thickening of the rocks due to flexuring. In the case of sharp rolls such as we find in the Juniata region the *resultant* thickness of any formation depends upon its structural position.

sand at any given point for the general explorer. There are however certain errors which exist to vitiate the accuracy of the results in determining the local structure.

(1.) The elevation of the well mouths in most cases has been determined by barometer; (2,) the depth of the oil sand has been obtained from various sources and cannot always be relied upon within 10 to 20 feet; (3,) in some cases where the oil sand itself is overlaid by *sandy* measures the depth no doubt has been reported too high whereas it has been given too low where the oil sand itself is shaly and the strata immediately above are not sandy; (4,) the sand bed is subject to local and varying dips between the wells enumerated in the table and we have no means at hand to determine them.

§ 395. *Estimated elevations of the Bradford oil sand.*

NAME OF WELL AND LOCATION.	Elevation of top of well.	Depth to top of Bradford oil sand.	Elevation of top of sand.	Total depth of well.
Cattaraugus county, New York.				
1. Benie, Trumbower & Co., north fork, south branch of Indian creek, . .	1785	1215	570	1352
2. McMullen and Hancock, Indian creek, ...	1785	1230?	555	
3. Follett, north fork, south branch of Indian creek, ...	2030?	1481	549	
4. James No. 1, north of Rock City, .	1960	1480	480	1547
5. Johnson four mile run, No. 1, . .	1845	1370	475	1471
Foster Brook, McKean county.				
6. Van Vleck, No. 1, Lafferty farm, . .	1577	1130	457	1175
7. Van Vleck, No. 2, Lafferty farm,	1632	1176	456	
8. Germor & Cary, Jno. McMurray farm, ...	1530	1070±	456	1175
9. Clark, Babcock & Hulings, No. 1, .	1474	1024	450	1114
10. McMurray, R. McMurray farm, . .	1574	1127	447	1181
11. Clark, Babcock & Hulings, No. 3, .	1500	1060	440	1117
12. O'Neill, Snyder farm, ...	1650	1220	430	1265
13. Prentice, No. 8, adjoining Lafferty farm, ...	1772	1332	440?	
14. Prentice, No. 8, Melvin farm, Tarport, ...	1440±	1010	430	
Bradford.				
15. Jackson & Walker, No. 7, Kennedy lease, ...	1474	1060	414	

16. Prentice, Mount Raub, ...	2040	1627±	413±	1768
17. John McKeown near Rixford, . .	1670	1258	412	
18. H. L. Taylor, No. 1, Dykeman farm,	1552	1156	396	
19. Dennis, No. 1, Roger's farm, ...	2055	1664	391	1719
East branch.				
20. Emery & Patterson, Morris estate, Toad Hollow, ...	1582	1196	386	1238
21. Keown & Vaughan, Cutting farm, DeGolier, ...	1501	1124	377	
22. C. S. Whitney, No. 1, James DeGolier farm, ...	1514	1137	377	
23. Echart, Foster farm, Shepard run, .	1565	1210	355	1255
24. Kennedy, No. 1, Smith farm, Shepard run, ...	1575	1235	340	
25. Vicinity Lewis run R. R. station, .	. . .	. . . . .	294	
26. Emery & Patterson, Lewis run, No. 1,	1645	1371	274	1390
27. Emery & Patterson, Lewis run, No. 2,	1895	1636	259	1707
28. Prentice, Lewis run, Moody tract, .	1599	1378	221	
29. Prentice R. R. run near Big Shanty,	1633	1497	136	
30. King, No. 1, Big Shanty, ...	1667	1545	122	1663
Smethport.				
31. Brant, No. 3, ...	1775	1510	265	
32. Smethport, No. 1, ...	1590	1340	250	2004
33. Brant, No. 2, ...	1606	1360	246	1805
34. Lucius Rogers, ...	1531	1300	231	
35. Brant & Co., Wilcox tract, ...	1517	1293	224	
36. Haskill (Brant, No. 1,) (?), ...	1552	1345	207	1861
37. Hamar & Ernhout, Fletcher farm, .	1715	1615±	100±	2230
38. Hulings, No. 1, Kinzua creek, . . .	1625	1545	80	
39. Hulings, No. 3, Kinzua creek, . . .	1715	1665	50	
40. Kinzua well, (dry hole,)	1718	1745(?)	— 27?	1785
41. Wilcox, No. 3, ...	1666	1685	— 19	1850
42. Wilcox, No. 2, ...	1642	1679	— 37	2004
43. Coburn well, near Sergeant, ...	1900	1968	— 68	2263
44. Ernhout & Taylor, No. 2, ...	1730	1815	— 85	2000
45. Hukill, near Ludlow, ...	1846	1950	—104	1989
46. Bear creek, Elk county, ...	1595	2150 (computed)	—555 (computed)	1998

§ 396. From these elevations I have determined the average dip per mile in feet of the sand between prominent points throughout the oil territory of the county. It must be remembered that the dips which are recorded are not all within the limits of proven productive oil territory, but are the estimated dips between points far removed, where the Bradford sand is reported to have been found. A study of the table in conjunction with the accompanying map of the oil districts of McKean county (plate XVII) will show at a glance the relative position of the line of dip to the developed territory:

§ 397. *Estimated dips of the Bradford oil sand.*

Locality and Elevation of the top of the Bradford oil sand.		Distance in miles.	Direction.	Average dip per mile in feet.
From	To			
Rock city, 480',	Rixford, 412'.	6.25	S. 15° W.	11
Rock city,	Tarpot, 430'.	9.	S. 66° W.	5½
Tarpot, 430',	Bradford, 414'.	1.25	S. 55° W.	13
Tarpot,	Smethport,* 250'.	13.	S. 40° E.	14
Tarpot,	State Line, 384'.	2.5	N. 10° E.	18
Rixford, 412',	Smethport, 250'.	7.75	S. 15° E.	21
Rixford,	Lewis run, 294'.	9.	S. 67° W.	13
Bradford, 414',	DeGolier, 377'.	3.	S. 8° W.	12½
Bradford,	Hukill well, —104'.	20.	S. 44° W.	26
DeGolier, 377',	Lewis run, 294'.	2.25	S. 8° W.	37
Lewis run, 294',	Big Shanty, 122'.	2.5	S. 14° E.	69
Lewis run,	Smethport, 250'.	11.	S. 68° E.	4
Smethport, 250',	Hulings well, No. 1, 80'.	12.75	S. 71° W.	18½
Smethport,	Wilcox well,† —19'.	17.25	Southwest,	15½
Hulings well No. 1, 80',	Wilcox well,	8.25	South,	12
Hulings well, No. 1,	Hukill well, 104'.	11.50	S. 85° W.	16
Wilcox well, —19',	Bear creek well, —555'.	8.	South,	67

* Smethport well, No. 1. * Wilcox well, No. 3.

The dip of the sand within the enclosed area known as the Bradford District proper ranges from 5½' per mile as a minimum between Rock City and Tarport to 13' as a maximum between Tarport and Bradford. An average dip may be stated to be 10 feet.

Production.

§ 398. The accompanying statistics of well account, of production and stocks of petroleum in the district have been

taken from STOWELL'S PETROLEUM REPORTER and tabulated in convenient form for reference. Entire dependence cannot be placed on all the estimates, but as they are the most reliable ones we have on record they are published here as showing many facts of great interest and value.

The production and stocks are given in barrels of 42 gallons.

§ 399. *Production, Stocks, and Well Account in the Bradford Oil District, September, 1875, to June, 1880.*

	PRODUCTION.		STOCKS.	WELL ACCOUNT.							
									NEW WELLS.		
	Total.	Daily average.		Number producing.	Number drilling.	Number completed.	Number dry holes	Number rigs building.	Aggregate daily production.	Average daily production.	Monthly average price at wells.
1875.	*Bbls.*	*Bbls.*	*Bbls.*						*Bbls.*	*Bbls.*	
September,	4,500	150	2,000	9	7	. . .	. . .	. . .	. . . .	. . .	1.33
October,	4,650	150	2,535	8	10	. . .	. . .	. . .	. . . .	. . . .	1.32½
November,	4,740	158	3,715	12	11	. . .	. . .	. . .	. . . .	. . . .	1.44
December,	4,619	149	2,090	15	20	. . .	. .	. .	. . . .	. . . .	1.55
1876.											
January,	9,455	305	8,329	25	17	. . .	. . .	. . .	. . . .	. . .	1.80
February,	10,991	379	12,529	37	20	13	2	.	. . .	19	2.00
March,	15,562	502	21,766	44	34	13	. . .	48	234	18	2.01
April,	20,400	680	31,642	60	41	. .	. . .	. .	. . .	. . .	2.02½
May,	24,490	790	32,024	82	53	25	1	52	390	15	1 90½
June,	24,000	800	13,337	100	55	18	3	20	112	6¼	2.01¾
July,	33,325	1,075	19,000	150	57	34	3	59	507	15⅛	2.24⅛
August,	35,185	1,135	15,630	200	56	50	5	58	650	13	2.71⅜
September,	47,790	1,593	20,595	268	68	31		74	412	13.33	3.81
October,	51,770	1,670	23,287	323	96	55	3	65	550	10	3.37½
November,	54,000	1,800	27,187	360	116	46	2	71	460	10	3.11
December,	55,800	1,800	39,554	400	96	42	7	62	390	9.33	3.73

1877.											
January,	58,900	1,900	54,379	400	98	58	7	67	580	10	3.58¼
February,	58,800	2,100	57,000	400	91	80	5	58	180	6	2.70
March,	71,300	2,300	93,755	450	55	61	5	54	630	10.3	2.67½
April,	74,400	2,580	117,884	535	67	43	1	60	510	12	2.58
May,	100,533	3,243	130,566	580	78	59	5	42	514	8.7	2.24
June,	103,470	3,449	133,975	650	54	57	5	46	515	9	1.94⅝
July,	112,003	3,613	181,700	700	68	45	4	80	600	13.33	2.07½
August,	137,300	4,430	133,203	700	90	40	1	104	500	12.5	2.51
September,	148,230	4,941	107,458	750	156	83	5	158	1,000	12	2.38
October,	172,515	5,565	133,657	900	188	120	9	157	1,200	10	2.56¾
November,	180,000	6,000	133,000	965	218	120	8	152	1,200	10	1.91
December,	248,000	8,000	255,000	1,000	142	145	6	176	2,500	17.5	1.80
1878.											
January,	271,250	8,750	367,350	1,100	149	107	2	177	1,500	14.3	1.43
February,	275,016	9,822	616,186	1,200	185	98	6	224	1,470	15	1.65¼
March,	354,950	11,450	762,598	1,300	248	110	8	263	1,750	7	1.59
April,	360,000	12,000	875,000	1,500	285	220	6	283	3,500	16	1.37½
May,	456,320	14,720	989,041	1,700	284	346	12	234	5,650	16	1.35¼
June,	480,000	16,000	1,000,000	1,900	187	193	6	196	3,150	16.5	1.14
July,	542,500	17,500	925,000	2,040	132	151	11	182	2,450	16.25	.98¾
August,	604,500	19,500	1,000,237	2,172	132	142	3	184	2,000	14	1.01
September,	660,000	22,000	1,264,978	2,420	182	120	9	223	1,900	16	.86⅝
October,	723,230	23,330	1,376,740	2,600	222	186	9	263	2,572	14	.82⅛
November,	746,280	24,876	1,610,698	2,800	230	200	9	250	2,500	12.5	.89⅜
December,	734,700	23,700	2,001,271	2,950	162	127	6	215	1,824	11.25	1.16
1879.											
January,	775,000	25,000	2,542,507	3,000	203	112	8	320	1,960	17.50	1.03
February,	700,000	25,000	2,874,990	3,100	260	107	5	359	2,140	20	.98
March,	927,365	29,915	3,213,809	3,310	348	204	10	426	4,748	23.20	.86¼
April,	979,170	32,639	3,567,686	3,500	432	229	6	375	6,372	27.4	.78½
May,	1,091,107	35,197	3,793,661	3,850	400	365	10	343	8,942	24.50	.76
June,	1,140,000	38,000	4,077,497	4,100	350	300	5	320	8,000	26.66	.68⅜
July,	1,240,000	40,000	4,461,513	4,400	276	299	8	249	7,207	24	.69⅞
August,	1,446,119	46,649	4,809,793	4,600	202	221	3	252	5,861	26.7	.67⅛
September,	1,441,710	48,057	5,284,544	4,775	225	174	6	241	4,603	26.4	.69⅜
October,	1,429,038	46,098	5,745,957	4,875	239	180	5	314	4,860	27	.88⅛

November,	1,350,000	45,000	5,945,957	5,000	294	163	6	383	4,055	24.3	$1.05\frac{5}{8}$
December,	1,395,000	45,000	6,365,728	5,100	375	182	4	421	3,765	20.7	$1.18\frac{1}{8}$
1880.											
January,	1,374,757	44,347	6,618,335	5,140	429	262	10	490	4,500	17	$1.10\frac{1}{4}$
February,	1,318,050	45,450	6,874,264	5,300	476	240	2	565	5,860	24.4	$1.03\frac{1}{8}$
March,	1,655,028	53,388	7,330,920	5,450	530	325	10	534	7,637	23.5	$.88\frac{3}{4}$
April,	1,699,620	56,654	7,998,342	5,800	500	462	8	475	10,800	22.33	.78
May,	1,782,500	57,500	8,873,342	6,150	410	390	8	360	9,750	35.	.80
June,	1,740,000	59,000	10,000,000	6,350	390	290	5	379	7,372	25.25	1.00

§ 400. These statistics I have placed in the form of graphical diagrams (Plates XV and XVI) so that the characteristics of the development and production of the Bradford district may be more readily appreciated.

§ 401. In diagram Plate XVI the daily production, the average price and total stocks are represented for every month from January, 1876, to April, 1880, inclusive. The most irregular line on this plate is that showing the average price.

The maximum average price of \$3.81 per barrel was attained in September, 1876, the minimum price of 67⅛ cents in August, 1880. The statistics of this district are of course influenced by the petroleum trade not only of the State but of the world so that the actual cause for an increase or decrease in the estimates cannot be surmised by a study of this district alone. General conclusions however can be arrived at of interest and value. For instance the rapid and almost continued decrease in the average price per barrel since October, 1877, is due directly to the very rapid increase in the number of barrels daily produced and the great accumulation of stocks.

§ 402. By reference to the diagrams it will be seen that from June to October, 1877, the price of oil advanced from \$1.94⅝ to \$2.56⅞; during this same period the daily production also increased. In reviewing this fact the *Petroleum Reporter* says:

"About April the close-handed control of the refining interests was broken. A war of competition ensued . . . which had the effect of reducing freights as well as refiners' margins. The consumer and exporter taking advantage of this condition . . . . bought heavily with occasional intermission, during the whole season up to October. Oil went more generally to new places of consumption than in any previous year, the old ports became more heavily stocked than ever before, and even the interior consuming points took unaccustomed stocks. The immediate consequence of this was an extraordinary increase in the development and production of crude material."

§ 403. When this chart is compared with diagram plate

XV, showing the well account, a reason can be readily assigned for the increased daily production. It will be noticed that since about the same time (October, 1877) the number of completed wells increased with several notable fluctuations, while the number of dry holes remained about the same, showing a falling percentage, and that the average daily production of the new wells increased. This indicates that as the development advanced the risk of failure from a liability to obtain dry holes and smaller producing wells became very much less. The cause of the rapid increase in the accumulation of stocks cannot be directly determined from a study alone of these tables. It is quite natural to infer that the cause was over-production. But we could not assert why there was an over-production.*

§ 404. A notable fact in the number of wells drilling and completed is quite boldly marked. If the two diagrams are again compared, it will be seen that in October, 1877, when the price of crude per barrel began to fall rapidly, the number of wells drilling and completed perceptibly increased. This resulted from the fact that the *bear element* controlled the market, and not only depressed the price of crude, but the cost of labor and drilling material. The market was depressed by those bears who believed that the field was illimitable, and that the probable production would very far exceed all possible consumption, consequently the price must fall. On the other hand the bulls in the market who believed that the boundary of the district was pretty definitely determined,† and that the sudden fall in the price of crude was only temporary, took advantage of the low price of labor and material to start new wells. This same thing is shown in the early part of 1879 and the early part

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* Over-production may result from numerous causes: diminished consumption; increase of import tariff at foreign ports; increase in the production of foreign fields; more stringent laws regulating safety of burning oil by which the more volative products might be condemned, &c., &c.

† The area of the *proven oil territory* in the Bradford District, May 1st, 1880, was 90 square miles, (see plate XVII.) The area of proven territory at the same date in the Limestone District, was 6 square miles; in the Big Shanty District, 2 square miles; in the Kinzua District, 3½ square miles—total for the county, about 100 square miles.

of 1880. In these two latter cases, of course, a good deal of the increased activity in the WELL ACCOUNT is due to the milder weather of spring, when the drillers' work can be more easily prosecuted than in the severer weather of winter.

§ 405. A close study of these diagrams will reveal many interesting facts which do not suggest themselves upon a hurried glance.

§ 406. As has been stated (page 283), the percentage of dry holes in the district is smaller than anywhere else in the State. No general estimates are at hand to show the relative failures in drillings met with in the several portions of the field. The accompanying table, compiled from facts contained in "The Era," July 1, 1880, shows the character of the development along Cole creek, in Keating, Bradford, and Otto townships.

Cole Creek development.

MONTH.	No. of wells drilled.	No. of dry holes.	Average daily production of new wells.	Total daily production.
April, 1879,	3	....	56	168
May, "	10	....	66	665
June, "	18	...	66	1,193
July, "	39	3	59	2,120
August, "	46	...	56	2,566
September, "	42	1	51	2,083
October, "	37	....	45	1,681
November, "	35	2	44	1,465
December, "	47	....	40	1,889
January, 1880,	40	....	41	1,647
February, "	46	...	43	1,967
March, "	42	....	36	1,503
April, "	75	1	42	3,117
May, "	64	....	59	3,758
June, "	58	...	58	3,386
Total,	602	7		

The Cole creek territory is exceptionally prolific, and cannot be taken as an average of the oil territory found in McKean. The largest wells have been found here. A num-

ber of them, for several weeks after the sand was first struck, were reported as producing between 300 and 500 barrels per diem. The new wells obtained in the whole district, from April, 1879, to the present time, produced on an average, 17 to 27 barrels of oil a day. The production of those in the Cole creek region during the same time averaged from 36 to 66 barrels a day.

In this territory only $1\frac{1}{10}$ per cent. of all the wells drilled have proved dry. This is much less than the percentage of dry holes for the entire region,* as may be seen by reference to WELL ACCOUNT, in the first table given.

Cost of an Oil Well at Bradford.

The following estimates of the cost of drilling and equipping a producing (flowing or pumping) oil well in the Bradford district, July 26, 1880, have been furnished me by Hon. Lewis Emery, Jr., of Bradford, to whom I am indebted not only for these figures, but for other valuable information in regard to the development of this district.

In his letter accompanying the estimates, Mr. Emery says: "I inclose you prices of everything as the market is to-day, (July 26.) I know them to be correct in every particular. Tubing and casing is very cheap, so is drilling, but the market governs this trade, as well as any other."

Cost of a Flowing Well.

1. Carpenters' rig complete,	$400 00
2. Belt, bull-rope, engine, telegraph, water pipes, steam pipes, and fittings to connect engine and boiler,	100 00
3. Boiler (20-horse power,) on ground,	600 00
4. Engine (15-horse power,) on ground,	260 00
5. Contract for drilling; contractor to furnish fuel, tools, cable, sand pump line, &c., @ 57½ c. ℔ foot, say 1,500 feet,	862 50
6. Casing, say 300 feet @ 65 c. ℔ foot,†	195 00
7. Tubing, say 1,600 feet @ 18 c. ℔ foot,†	288 00
8. Torpedos, (20 quarts nitroglycerine,)	114 40
9. Packer,	20 00

*See page 303.

† The standard brands of tubing and casing, which have been sold respectively for twenty-five and eighty-five cents per foot for four months, are now in the market for eighteen and sixty-five cents.

10.	Working barrel,	8 00
11.	Casing head,	3 50
12.	T's and elbows for tank connections,	3 00
13.	One 25 barrel tank,	15 00
14.	One 250 barrel tank,	110 00
15.	Tank house,	40 00
16.	Expense of tubing and packing well,	7 50
17.	Expense for hauling, tubing, &c.,	10 00
	Total cost of well flowing,	$3,036 90

If the well is to be pumped, the following items are to be added to the above costs:

Additional cost of a Pumping Well.

1.	1,500 feet sucker rods @ 7 c. ℔ foot,	$105 00
2.	Valves for working barrel,	8 50
3.	Polished rod,	4 00
4.	Stuffing box,	2 25
5.	Adjuster,	8 00
6.	T's, elbows, &c., say,	5 00
		$132 75

Necessary tools for handling the tubing and sucker rods.

1.	Large pulley block,	$12 00
2.	Tubing elevators,	10 00
3.	Three pair of tubing tongs,	12 75
4.	Tubing cable,	25 00
5.	Sucker rod rope,	13 00
6.	Sucker rod, wrenches, and elevators,	7 00
		$79 75
	Total cost of a pumping well, and the necessary appliances for handling it,	$3,249 40

In this estimate, no allowance is made for "*drive pipe*," a short wooden conductor set by the rig builder, being all that is supposed necessary. In some localities where the soil and drift on the top of the bed-rock is more than 20 feet± thick, it is necessary to drive down to the bed-rock an 8 inch cast iron pipe, in sections of 9 feet. Some of the wells in McKean county require over 200 feet of "drive pipe," which cost $2 25 per foot;* this materially increases the cost of the well.

* November 1st, 1879, the price at present is much less.

CHAPTER XVI.

Descriptive Catalogue of Lithological Specimens.

§ 407. Three hundred and seventy-one hand specimens were collected by Mr. A. W. Sheafer and myself in McKean, Cameron, Elk, and Forest counties, illustrating the lithology from the MAHONING SANDSTONE at the base of the LOWER BARREN COAL MEASURES, downward through Nos. XIII, XII, XI, X, and IX, into the upper part of the Chemung, No. VIII.

This catalogue is published here, because it gives a careful description of each specimen, and the position in the formation which it occupies. In comparing the vertical sections throughout the report with these descriptions, the reader will be greatly assisted to a proper understanding of the character of the several formations.

§ 408. LOWER BARREN COAL MEASURES, NO. XIII.

Mahoning Sandstone.

371 and 370. Coarse, quartzose sandstone; from Goff farm, near Caledonia, Jay township, Elk county.

§ 409. LOWER PRODUCTIVE COAL MEASURES, NO. XIII.

369. Fossil tree trunk.
368. Morehead fire-clay; from Snyder township, Jefferson county.

§ 410. *Freeport Upper Limestone.*

367. Limestone; from the Hyde farm, west of Brandycamp hotel, Horton township, Elk county.
366. Limestone; from George Faust's farm, Horton township.

§ 411. *Freeport Lower Limestone.*

365. Limestone; from T. Foxes', Coal run, Horton township, Elk county.
364. Limestone; from east side of Brandycamp, Chamberlain's farm, Horton township.
363. Limestone; from near coal opening No. 10, Shawmut, Horton township.
362. Limestome; from George Faust's farm, Horton township.
361. Limestone; from Hyde farm, west of J. S. Chamberlain's, Horton township.
360. Limestone; from McAllister's farm, Brandycamp, Horton township.

§ 412. *Johnstown Cement Bed.*

359. Limestone; from McAllister's farm, Horton township.

§ 413. *Ferriferous Limestone.*

358. Limestone; from Freiburg, Clarion county.
357. Limestone; from Kyler's Corners, Fox township, Elk county.
356. Limestone (upper bed); from Kane's quarry, Johnson run, Elk county.
355. Limestone (lower bed); from Kane's quarry
354. Limestone; from Morehead's, Snyder township, Jefferson county.
353. Limestone; from Frost's, Brockwayville, Jefferson county.
352. Limestone; from Oyster's quarry, Brockport, Elk county.
351. Limestone; from Chauncy Brockway's, Horton township, Elk county.
350. Limestone; from J. S. Chamberlain's farm, Horton township, Elk county.
349. Limestone; from Brandycamp P. O., Horton township, Elk county.
348. Iron ore; from top of Ferriferous limestone, Winslow farm, Benezette township, Elk county.

347. Limestone; from G. W. Winslow's farm, Benezette township.
346. Limestone; from G. W. Winslow's farm.

POTTSVILLE (SERAL) CONGLOMERATE, NO. XII.

§ 414. *Johnson Run Sandstone.*

Specimens 345 to 332, inclusive, from Kane, Wetmore township, McKean county.

345. Coarse-grained, gray sandstone.
344. Compact, yellow sandstone.
343. Gray and yellow, coarse-grained sandstone.
342. Coarse-grained, quartzose sandstone.
341. Yellowish-gray sandstone.
340. Coarse-grained, gray and yellow sandstone.
339. Gray, quartzose sandstone.
338. Gray, quartzose sandstone.
337. Iron-stained sandstone.
336. Coarse, gray sandstone.
335. Compact, iron-stained sandstone.
334. Coarse, gray, quartzose sandstone.
333. Iron-stained sandstone.
332. Olive, compact, quartzose sandstone.

§ 415. *Alton Coal Group.*

331. Fire-clay (average of bed); from Glen Mayo colliery, near Johnsonburg, Ridgway township, Elk county.
330. Fire-clay (from 3′ above coal); from Glen Mayo colliery.

§ 416. KINZUA CREEK SANDSTONE.

Brockport.

Specimens 329 to 323, inclusive, from vicinity of Brockport, Horton township, Elk county.

329. Iron ore.
328. Dark, compact sandstone.
327. Gray, quartzose sandstone.
326. Gray, compact sandstone.

325. Gray, compact sandstone.
324. Dark, compact sandstone.
323. Sandstone (Sigillaria).
322 to 320, inclusive; coarse-grained, gray sandstone from Morgan farm, Benezette township, Elk county.

Benezette.

Specimens 319 to 316, inclusive, from vicinity of Benezette, Elk county.

319. White pebble conglomerate, containing thin seam of coal.
318. Conglomerate.
317. Coarse-grained, gray sandstone.
316. Fine-grained, gray and yellow sandstone.

Benezette Fire-clay.

315. Iron ore; from Harbison and Walker's clay mine, near Benezette, Elk county.
314, 313. Fire-clay; from Barr and Radcliffe mine, near Benezette.
312 to 310, inclusive. Fire-clay; from Jones' mine, near Benezette.
309 to 307, inclusive. Fire-clay; from Harbison and Walker's mine.

§ 417. *Olean Conglomerate.*

Forest county.

306. White pebble conglomerate; from Neillsburg, Harmony township.
305. Conglomerate; from Neillsburg.
304. Gray, compact, flinty, quartzose sandstone; from Wesley chapel, Harmony township.
303. White quartzose sandstone; from Wesley chapel.
302. Conglomerate; from Neillsburg, Harmony township.
301. White, micaceous, soft, sandy clay; from Pleasantville road 1½ miles from Tionesta, Tionesta township.
300. Soft, coarse-grained, quartzose sandstone; from Pleasantville road.

299. Pebble conglomerate; from Fagundas.
298. Gray, massive, quartzose sandstone; from Tionesta.
297. Conglomerate; from Foxburg, Howe township

Kinzua creek.

Specimens 296 to 291 inclusive, from Kinzua creek, Corydon township, Warren county.

296. Coarse, quartzose sandstone.
295. Conglomerate.
294. Pink, quartzose sandstone.
293. Conglomerate.
292. Conglomerate; large pebbles.
291. Conglomerate.

Ridgway.

Specimens 290 to 287, inclusive, from Ridgway, Elk county.

290. Compact quartzose sandstone.
289. Compact sandstone.
288. Brown, compact sandstone.
287. Gray sandstone.
286. Conglomerate; from Brockport, Horton township, Elk county.
285. Gray, compact sandstone; from Caledonia, Jay township, Elk county.

Laurel run.

Specimens 284 to 278, inclusive, from Laurel run, near Caledonia, Jay township, Elk county.

284. Conglomerate.
283. Conglomerate; large pebbles.
282. Conglomerate.
281. Pebbles from conglomerate.
280. Conglomerate.
279. Conglomerate; small pebbles.
278. Compact, gray, conglomeritic sandstone.

Benezette.

Specimens 277 to 271 inclusive, from vicinity of Benezette, Elk county.

277. Compact, gray sandstone.
276. Coarse, gray quartzose sandstone.
275. Conglomerate.
274. Conglomerate; large pebbles.
273. Conglomerate.
272. Conglomerate.
271. Coarse-grained, quartzose sandstone.
270. Gray and yellow, coarse-grained sandstone; from Driftwood, Cameron county.

Sinnemahoning.

Specimens 269 to 265, inclusive, from Sinnemahoning, Grove township, Cameron county.

269. Coarse, gray, quartzose sandstone.
268. Conglomerate.
267. Coarse, quartzose sandstone.
266. Conglomerate.
265. Conglomerate and sandstone.

§ 418. Mauch Chunk (Umbral), No. XI.

264. Sandy fire-clay; from Benezette, Benezette township, Elk county.
263. Iron ore; from Trout run near Benezette.
262. Iron ore; from Benezette.
261. Red clay and argillaceous shale; from Ridgway, Ridgeway township, Elk county.

§ 419. Pocono (Vespertine,) No. X.

260. Thin micaceous flaggy sandstone; from road crossing West Hickory creek at W. Gorman's, Harmony township, Forest county, 1 mile southwest of Fagundas.
259. Gray, iron-stained flaggy sandstone; from Gorman's.

Hickory.

Specimens 258 to 254, inclusive, from vicinity of Hickory station, Harmony township, Forest county.

258. Gray, flaggy, micaceous sandstone. Elevation, 1620′ above tide.
257. Olive, fine-grained, massive sandstone 1245′ above tide.
256. Dark, gray, flaggy sandstone; 1175′ above tide.
255. Green, flaggy sandstone.
254. Yellow, fine-grained sandstone.

Tionesta.

Specimens 253 to 219, inclusive, from vicinity of Tionesta, Tionesta township, Forest county.

253. Fine-grained quartzose sandstone, 1600′+ above tide.
252. Iron ore, 1590′ above tide.
251. Red and green shale, 1480′ above tide.
250. Green massive sandstone, 1480′ above tide.
249. Gray, thin bedded sandstone, 1385′ above tide.
248. Gray, iron-stained, gritty sandstone, 1385′ above tide.
247. Light, fine-grained, compact sandstone, 1225′ above tide.
246. Green, flaggy, sandstone, 1210′ above tide.
245. Limestone, 1180′ above tide.
244. Gray, fine-grained, compact, massive sandstone, 1175′ above tide.
243. Gray, fine-grained sandstone, 1175′ above tide.
242. Iron-stained slate.
241. Bluish-gray, fine-grained sandstone, 1160′ above tide.
240. Green, flaggy sandstone, 1150′ above tide.
239. Gray, fine-grained sandstone.
238. Dark gray, micaceous sandstone 1060′ above tide.
237. Dark gray slate.
236. Coarse-grained soft sandstone.
235. Green flags.
234. Green, shaly sandstone.
233. Green shale.
232. Gray, fine-grained, flaggy sandstone.
231. Green, micaceous sandstone.

230. Gray, flaggy, micaceous sandstone.
229. Light-gray, fine-grained sandstone.
228. Light-gray, fine-grained sandstone.
227. Gray, fine-grained, massive sandstone.
226. Dark slate.
225. Small pebble conglomerate.
224. Small pebble conglomerate.
223. Green, massive sandstone, containing bands of small pebble conglomerate.
222. Red, shaly sandstone.
221. Reddish-gray, micaceous slate.
220. Dark slate.
219. Black, micaceous slate.

§ 420. *Sub-Olean Conglomerate.*

218. Sub-Olean conglomerate containing small pebbles; from Morrison's dam, north branch of Sugar run, Corydon township, McKean county.

Kinzua Creek.

Specimens 217 to 212, inclusive, from Kinzua creek, Corydon township, Warren county.

217. Conglomerate.
216. Conglomerate.
215. Conglomerate.
214. Conglomerate.
213. Conglomerate.
212. Conglomerate.

Specimens 211 to 192, inclusive, from vicinity of Tally Ho pump station, oil pipe line, Kinzua creek, Lafayette township, McKean county.

211. Coarse, ferruginous sandstone.
210. Slaty sandstone.
209. Iron-stained sandstone.
208. Ferruginous sandstone.
207. Ferruginous sandstone.
206. Ferruginous sandstone.
205. Ferruginous sandstone.
204. Ferruginous sandstone.

203. Ferruginous sandstone.
202. Ferruginous sandstone; contains shell casts.
201. Coarse ferruginous sandstone; contains shell casts.
200. Iron-stained sandstone.
199. Iron-stained sandstone.
198. Ferruginous conglomerate.
197. Sub-Olean conglomerate pebbles.
196. Conglomerate.
195. Conglomerate.
194. Conglomerate.
193. Conglomerate.
192. Olive, fine-grained sandstone.
191. Conglomerate; from Hubert run, Wetmore township, McKean county.
190. Conglomerate; from Hubert run.
189. Green, flaggy sandstone; Wilmarth, Ridgway township, Elk county (Upper Pocono.)
188. Conglomerate; 220′ below top of formation, Ridgway, Ridgway township, Elk county (Sub-Olean Cong.)

§ 421. Lower Pocono, No. X.

Caledonia.

Specimens 187 to 184, inclusive, from Caledonia tunnel, Jay township, Elk county.

187. Flaggy, micaceous sandstone.
186. Green shale.
185. Olive, micaceous, massive sandstone.
184. Gray, massive sandstone.

Benezette section.

Specimens 183 to 146 incl. from vicinity of Benezette, Benezette township, Elk county.

183. Olive, flaggy sandstone; top of formation.
182. Gray, thin bedded sandstone; top of formation.
181. Gray, flaggy sandstone; 35′ below top of formation.
180. Olive, gritty, flaggy sandstone; 35′ below top of formation.

179. Olive, micaceous sandstone; 85′ below top of formation.
178. Gray, micaceous massive sandstone; 85′ below top of formation.
177. Grayish-yellow, gritty sandstone; 90′ below top of formation.
176. Greenish-gray, sandy slate; 90′ below top of formation.
175. Green, micaceous, flaggy sandstone; 90′ below top of formation.
174. Gray, gritty, massive sandstone; 110′ below top of formation.
173. Olive, micaceous, slaty sandstone; 110′ below top of formation.
172. Green, micaceous sandstone; 145′ below top of formation.
171. Olive, micaceous sandstone; 162′ below top of formation.
170. Green, slate; 150′ below top of formation.
169. Green, slate; 150′ below top of formation.
168. Gray, massive sandstone; 150′ below top of formation.
167. Olive, micaceous, massive sandstone; 165′ below top of formation.
166. Green, micaceous sandstone; 170′ below top of formation.
165. Green, micaceous, flaggy sandstone; 200′ below top of formation.
164. Olive, thin bedded, micaceous sandstone; 220′ below top of formation.
163. Dark slate; 285′ below top of formation.
162. Gray, micaceous, massive sandstone; 285′ below top of formation.
161. Gray, gritty, massive sandstone; 285′ below top of formation.
160. Green slate; 285′ below top of formation.
159. Iron ball; 280′ below top of formation.
158. Fossil limestone; 410′ below top of formation.
157. Olive, gritty sandstone; 415′ below top of formation.
156. Limestone; 415′ below top of formation.

155. Gray, massive sandstone; 440′ below top of formation.
154. Red and green, massive sandstone; 440′ below top of formation.
153. Green, shaly sandstone; 440′ below top of formation.
152. Green shales; 440′ below top of formation.
151. Red shale; 435′ below top of formation.
150. Gray, micaceous, massive sandstone; 440′ below top of formation.
149. Green, micaceous shaly sandstone; 445′ below top of formation.
148. Gray, massive, fine-grained sandstone; 445′ below top of formation.
147. Reddish-gray, micaceous sandstone; 450′ below top of formation.
146. Green, micaceous, massive sandstone; 450′ below top of formation.

*Driftwood Section.**

Specimens 145 to 111, inclusive, from hill immediately west of Driftwood, Gibson township, Cameron county.

145. Olive, micaceous, thin-bedded sandstone; top of formation.
144. Olive, micaceous, compact sandstone; top of formation.
143. Green, micaceous sandstone; 650′ above bottom of formation.
142. Olive, micaceous sandstone; 640′ above bottom of formation.
141. Olive, micaceous sandstone; 640′ above bottom of formation.
140. Olive, micaceous, thin-bedded sandstone; 640′ above bottom of formation.
139. Olive, micaceous, thin-bedded sandstone; 630′ above bottom of formation.

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*A great number of specimens were collected from the Pocono and Catskill in the vicinity of Driftwood. They are typical of these two formations and bear a very marked resemblance to those obtained from the same rocks in other parts of the State. A careful survey of the specimens and sections will without doubt show the justness of the division which I have adopted for Nos. IX and X. Mr. Chance proposes quite a different grouping (see Report VVV.)

138. Olive, micaceous, flaggy sandstone; 600′ above bottom of formation.
137. Green, micaceous, thin-bedded sandstone; 560′ above bottom of formation.
136. Olive, micaceous sandstone; 560′ above bottom of formation.
135. Olive, micaceous sandstone; 540′ above bottom of formation.
134. Green, micaceous sandstone; 540′ above bottom of formation.
133. Green, micaceous, thin-bedded sandstone; 515′ above bottom of formation.
132. Olive, micaceous sandstone; 500′ above bottom of formation.
131. Olive, flaggy sandstone; 440′ above bottom of formation.
130. Green, micaceous, flaggy sandstone; 440′ above bottom of formation.
129. Green, micaceous, flaggy sandstone; 400′ above bottom of formation.
128. Red, micaceous sandstone; 330′ above bottom of formation.
127. Green, micaceous sandstone; 280′ above bottom of formation.
126. Gray, gritty, flaggy sandstone; 260′ above bottom of formation.
125. Red, micaceous sandstone; 245′ above bottom of formation.
124. Red, flaggy sandstone; 245′ above bottom of formation.
123. Gray, micaceous, thin-bedded sandstone; 200′ above bottom of formation.
122. Gray, micaceous sandstone; 200′ above bottom of formation.
121. Red, micaceous, thin-bedded sandstone; 180′ above bottom of formation.
120. Red, micaceous, flaggy sandstone; 160′ above bottom of formation.
119. Gray, micaceous sandstone; 140′ above bottom of formation.

118. Red, thin-bedded, micaceous sandstone; 140′ above bottom of formation.
117. Gray, thin-bedded sandstone; 125′ above bottom of formation.
116. Green, micaceous sandstone; 120′ above bottom of formation.
115. Red, thin-bedded, micaceous sandstone; 110′ above bottom of formation.
114. Red, micaceous sandstone; 90′ above bottom of formation.
113. Gray, micaceous sandstone; 80′ above bottom of formation.
112. Red, micaceous, thin-bedded sandstone; 70′ above bottom of formation.
111. Red, micaceous sandstone; 60′ above bottom of formation.

Sinnemahoning Section.

Specimens 110 to 89, inclusive, from Ellicott's run, one mile northeast of Sinnemahoning, Grove township, Cameron county.

110. Olive, close-grained, micaceous sandstone; 725′± above bottom of formation.
109. Olive, close-grained, micaceous sandstone; 720′± above bottom of formation.
108. Olive, micaceous, thin-bedded sandstone; 590′ above bottom of formation.
107. Sandy slate; 440′ above bottom of formation.
106. Olive, micaceous, thin-bedded sandstone; 350′+ above bottom of formation.
105. Blue, micaceous, iron-stained sandstone; 320′ above bottom of formation.
104. Gray, fine-grained sandstone; 300′ above bottom of formation.
103. Gray, gritty sandstone; 300′ above bottom of formation.
102. Gray, micaceous, thin-bedded sandstone; 300′ above bottom of formation.

101. Green, micaceous, sandstone ; 300′ above bottom of formation.
100. Gray, micaceous, thin-bedded sandstone ; 240′ above bottom of formation.
99. Green, micaceous, flaggy sandstone ; 210′± above bottom of formation.
98. Gray, micaceous, thin bedded sandstone ; 170′ above bottom of formation.
97. Green, gritty, fine-grained sandstone ; 160′ above bottom of formation.
96. Black coal slates ; full of stem impressions ; 150′ above bottom of formation.
95. Green, micaceous, fine-grained sandstone ; 140′ above bottom of formation.
94. Bluish-gray, calcareous sandstone ; contains crinoid stems ; 100′ above bottom of formation.
93. Green, micaceous, flaggy sandstone ; 100′ above bottom of formation.
92. Green, gritty sandstone ; 90′ above bottom of formation.
91. Green, micaceous, sandstone ; 70′ above bottom of formation.
90. Blue, calcareous sandstone ; 20′± above bottom of formation.
89. Gray, micacaceous, flaggy sandstone ; 20′± above bottom of formation.

§ 422. Catskill (Ponent), No. IX.

Kinzua creek.

Specimens 88 to 75 inclusive from Kinzua creek, near Tally Ho pumping station, Hamlin township, McKean county.

88. Red shale.
87. Red shale.
86. Ferruginous, micaceous sandstone.
85. Red shale.
84. Red, micaceous, shaly sandstone.
83. Dark red shale.

82. Red, argillaceous shale.
81. Green shale.
80. Green, micaceous, flaggy sandstone.
79. Green, micaceous, flaggy sandstone.
78. Red, argillaceous shale.
77. Green, flaggy, micaceous sandstone.
76. Red argillaceous, micaceous sandstone.
75. Red argillaceous, micaceous sandstone.

*Driftwood section.**

Specimens 74 to 57 inclusive from hill immediately west of Driftwood, Gibson township, Cameron county.

74. Red and gray, micaceous, flaggy sandstone: top of formation.
73. Red, massive sandstone; 10′ below top of formation.
72. Red, micaceous sandstone; 60′ below top of formation.
71. Gray, thin-bedded sandstone; 80′ below top of formation.
70. Red, micaceous sandstone; 115′ below top of formation.
69. Gray, micaceous, massive sandstone; 120′ below top of formation.
68. Gray, micaceous, gritty sandstone; 150′ below top of formation.
67. Red, micaceous, thin-bedded sandstone; 160′ below top of formation.
66. Red, micaceous sandstone; 160′ below top of formation.
65. Red, micaceous sandstone; 170′ below top of formation.
64. Red, micaceous, flaggy sandstone; 170′ below top of formation.
63. Gray, flaggy sandstone; 190′ below top of formation.
62. Gray, micaceous sandstone; 190′ below top of formation.
61. Gray, micaceous sandstone; 210′ below top of formation.

*See note on page 319.

60. Red, micaceous, thin-bedded sandstone; 210′ below top of formation.
59. Red, micaceous, thin-bedded sandstone; 260′ below top of formation.
58. Green, micaceous sandstone; 310′ below top of formation.
57. Green, massive sandstone; 365′ below top of formation.

Specimens 56 to 44, inclusive, from side cut, south end of P. and E. R.R. yard, Driftwood, Cameron county.

56. Green, shaly sandstone; 490′ below top of formation.
55. Green, micaceous, flaggy sandstone; 490′ below top of formation.
54. Red, massive sandstone; 490′ below top of formation.
53. Red, massive sandstone; 490′ below top of formation.
52. Green, micaceous sandstone; 490′ below top of formation.
51. Greenish gray, micaceous sandstone; 490′ below top of formation.
50. Red, massive sandstone; 490′ below top of formation.
49. Red, micaceous, massive sandstone; 490′ below top of formation.
48. Green, massive, fine-grained sandstone; 490′ below top of formation.
47. Green, massive sandstone; 490′ below top of formation.
46. Gray slate; 490′ below top of formation.
45. Red, micaceous, shaly sandstone; 490′ below top of formation.
44. Red, micaceous sandstone; 490′ below top of formation.

Sinnemahoning section.

Specimens 43 to 38 inclusive from Ellicott's run, 1 mile northeast of Sinnemahoning, Grove township, Cameron county.

43. Red, micaceous, thin-bedded sandstone; top of formation.
42. Red, micaceous, shaly sandstone; near top of formation.

41. Green, gritty, flaggy sandstone; near top of formation.
40. Red, micaceous, shaly sandstone; near top of formation.
39. Soft, green slate; 50′ below top of formation.
38. Red, micaceous, massive sandstone.

Specimens 37 to 31 inclusive from west bank of the First fork at Sinnemahoning, Cameron county.

37. Green, massive sandstone; 425′ below top of formation.
36. Green, micaceous, sandy shale; 445′ below top of formation.
35. Red, micaceous sandstone; 445′ below top of formation.
34. Green and red sandstones; 445′ below top of formation.
33. Red, micaceous sandstone; 445′ below top of formation.
32. Gray, micaceous sandstone; 450′ below top of formation.
31. Green, argillaceous slate; 470′ below top of formation.

§ 423. Chemung (Vergent), No. VIII.

Morrison's dam.

Specimens 30 to 19 inclusive from below Morrison's dam, on North fork of Sugar run, Corydon township, McKean county.

30. Gray, micaceous shale.
29. Gray, massive sandstone.
28. Gray, micaceous, massive sandstone.
27. Iron-stained shale; full of shell casts.
26. Green, gritty sandstone.
25. Gray, massive sandstone.
24. Gray, micaceous sandstone.
23. Green, gritty sandstone; full of shell casts.
22. Gray, flaggy, micaceous sandstone.
21. Green, micaceous, shaly sandstone.
20. Gray, massive sandstone; full of shell casts.
19. Green, shaly sandstone; full of shell casts.

Emporium section.

Specimens 18 to 1 inclusive from the Sinnemahoning Portage creek, 1½ miles north of Emporium junction, Shippen township, Cameron county.

18. Gray, gritty slate.
17. Gray, micaceous sandstone; full of carbonaceous matter.
16. Olive slate.
15. Gray, flat pebble conglomerate.
14. Bluish-gray, fine-grained sandstone.
13. Green, micaceous flags.
12. Green, massive, conglomeritic sandstone.
11. Green, argillaceous shale.
10. Gray, micaceous sandstone.
9. Red conglomerate.
8. Gray, conglomeritic sandstone.
7. Gray, fine-grained, massive sandstone.
6. Gray, fine-grained, massive sandstone.
5. Green, iron-stained shale.
4. Gray, sandy slate.
3. Greenish-gray, fine-grained, massive sandstone.
2. Green shale.
1. Gray, fine-grained, micaceous sandstone.

NOTE—A number of observations were made upon the rocks of Cattaraugus county, New York, immediately north of McKean. All of them, together with a section constructed immediately south of Olean, go to confirm my division of the strata of McKean.

A northern dip seems to exist in the rocks to the north of the State line. This dip cannot continue for a great distance; it very probably changes along an east and west line (?) drawn through the town of Olean. This feature of the structure has no doubt determined the position of the HORSE-SHOE BEND of the ALLEGHENY RIVER.

REPORT OF PROGRESS R.

A.—Index to Names.

Index B. Geological.*

* By Joseph Lesley.

Index C. Beds.*

Arranged in the order of superposition from above downward.

* By Joseph Lesley.

ERRATA.

Map. See note to page 96.
Page 168, fifth line from bottom, for *Fourth* read *Fifth*.
Page 306, line nine, fill the blank with *888*.

NOTE.—A large number of maps and other valuable materials were contributed to the Survey by Col. Joseph D. Potts, President of the Empire Transit Company.—C. A. A.

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